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Sustainable Energy Action Plan for Kutaisi

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Sustainable Energy Action Plan for Kutaisi

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Introduction – Covenant of Mayors and City of Kutaisi

At the Covenant of Mayors Conference held in Georgia in October 2010, the role of cities as complex systems having a significant capacity to reduce greenhouse gas emissions was stressed. Municipalities have been identified as a main driving force in guiding the development and implementation of the Sustainable Energy Action Plan (SEAP) within EU energy efficiency priorities.

In 2011, by signing the Covenant of Mayors, Kutaisi City Hall joined an initiative under which Kutaisi should achieve reduction of greenhouse gas emissions by 20% by 2020 - a goal that will be achieved along with social and economic development of the city.

In order to achieve this goal, Kutaisi City Hall elaborated on the **Sustainable Energy Action Plan for Kutaisi**. The process of development of the SEAP was conducted within the frame of the project Capacity Building in Low Emissions Development / Pure Energy Program, supported by USAID. This includes::

- Developng a Baseline Emissions Inventory (BEI) in transport, outdoor lighting, waste, and greening sectors
- Developing a "Business as Usual" (BAU) Scenario for these sectors
- Defining mitigation measures for greenhouse gas emissions in these sectors for 2020 and assessing their efficiency
- Creating a monitoring plan
- Developing a strategy for raising local capacities and public awareness

The City of Kutaisi – A Brief Overview

Kutaisi's fast economic development, increasing population rate and increasing GDP per capita were taken as main baselines while developing the BAU scenario for 2020 and when planning concrete measures to reduce energy consumption and CO2 emissions. Implementation of the actions proposed in the AP will ensure a reduction of the overall CO2 emissions by at least 22, 9% for the designated sectors compared with the 2020 baseline emissions (BAU).

Kutaisi is the second largest city in Georgia both according to population number and area. It is located along both banks of the Rioni River in Western Georgia, where the river flows out of the deep, narrow gorge to the Kolkheti Lowlands. The altitude is only 80–120 meters above sea level, and its total "municipal area" is 70 km^2. The population lives mostly in the lowlands. To the northeast, Kutaisi is bounded by the Okriba Plain, to the north by the Samgurali Mountain Range, and to the southeast by the Kolkheti Lowlands. The northern area of the city is built on the elevated banks of the river, while the southern part covers Sapichkhia Hill. The city's strategic location connects East and West Georgia by a main highway between Sokhumi, Batumi, and Poti to the west and Tbilisi in the east (distance from Kutaisi 220 km). The North-Caucasian Road also connects the city to Samachablo, and the Kutaisi Railway (Brotseula – Tskaltubo and Rioni–Tkibuli lines) joins it to other main railway lines of the Caucasus.

The climate in Kutaisi is humid subtropical, thus summers are generally hot and winters are often dry and warm. The average annual temperature is 14.5˚C and annual precipitation averages 1730 mm[1].

[1] http://www.kutaisi.gov.ge/kutaisi-city/

Pic.1. View of central Kutaisi

Kutaisi is divided into 12 municipal units: City-museum, Avtoqarkhana, Uqimerioni, Dzelkviani, Kakhianouri, Vakisubani, Sapichkhia, Sulkhan-Saba, Nikea. Mukhnari, Gumati, and Gamarjveba. Two-thirds of the city's territory is residential. According to state data in 2012, the population of Kutaisi was 196 600. After World War II the population constantly grew at an average of 2.28% yearly, however since 1989 it began decreasing on average by 1.73 % yearly. Since 2005 it began increasing again though at a lower rate (0.86% on average) (See Fig. 1). From 2005 to 2012 the population increased by 6,2% overall and correspondingly the population density in the city increased significantly. It reached a level of 2,800 persons/ km^2 , exceeding the corresponding value for Tbilisi (2000 persons/km^2) by 40%. Kutaisi became 40 times more densely populated than the Georgian average of 67 persons/km^2 40.[2]

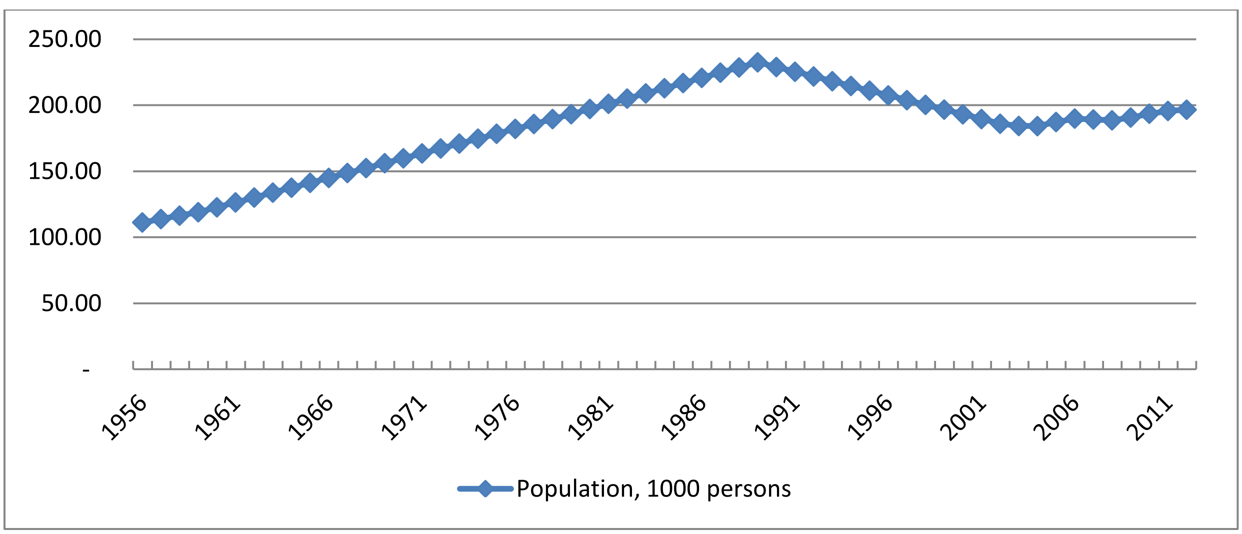


Fig. 1.Kutaisi population, 1000 persons

[2] http://nala.ge/uploads/kutaisi.pdf

Despite population growth, the emigration rate from Kutaisi is high, explained by a high rate of unemployment (22-25%). Though unemployment in Kutaisi is below the national average, it still is the main socio-economic problem of the city.

Table 1. Labor force (per thousand persons)[3]

	2009	2010	2011
Economically active population	**81.10**	**82.80**	**83.90**
Employed	**61.10**	**63.00**	**65.20**
Hired	47.00	48.30	49.30
Self-employed	14.00	14.50	15.80
Unclear	0.10	0.20	0.10
Unemployed	**20.00**	**19.80**	**18.70**
Population beyond labor force	49.60	50.10	50.20
Unemployment level %	**24.70**	**23.90**	**22.30**

Currently, the self-employed sector comprises about 16 -18% of the economically active population. The main factors contributing to a decreasing trend in unemployment in recent years, however, are significant investments in the economy of the city; increased attractiveness for investments; introduction of new technologies; favorable environment for tourism, etc. Some key developments have been the renovation of the Kutaisi Airport, the transfer of Georgia's Parliament from Tbilisi to Kutaisi, accompanied by the transfer of the Georgian National Energy and Water Supply Regulatory Commission, the Chamber of Control of Georgia, as well as the Public Service Halls and Roads Department of Georgia.

In 2010 a Free Industrial Zone was established in Kutaisi and in 2012 up to ten companies were operating there; however given the size of the city, the effect on unemployment has been negligible. More foreign investments are planned.

[3] Source: Kutaisi City Hall

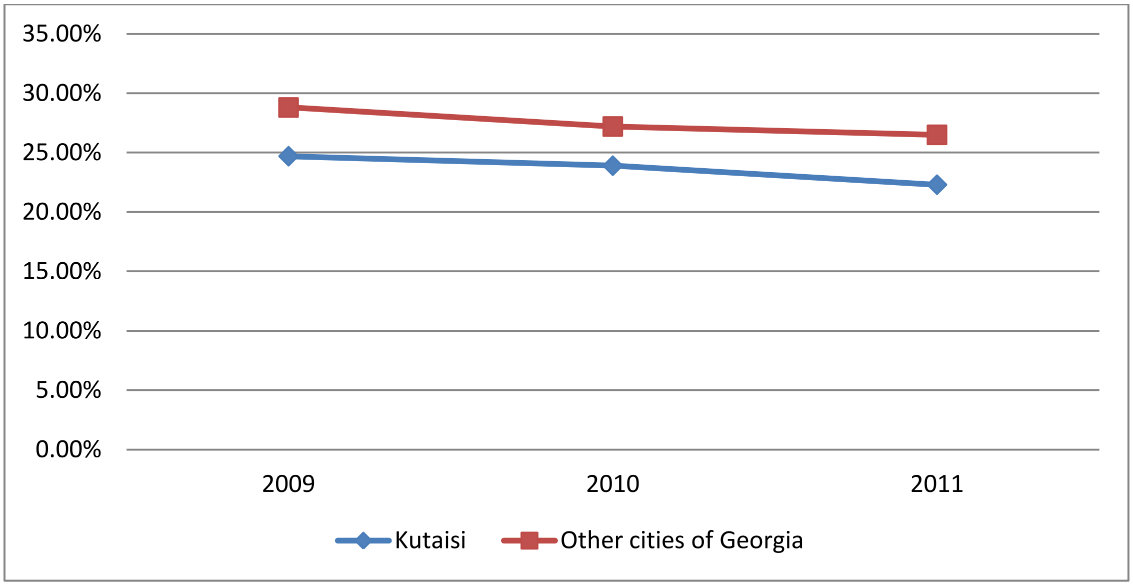


Fig. 2. Unemployment level, %[4]

During the Soviet times, several large industrial enterprises operated in Kutaisi, with up to 50 thousand people employed. After Perestroika, from 1990-1995, a de-industrialization process led to a drastic drop in production levels and thus to significant decreases in the industrial sector's share in the city's revenue. Positive changes in the economy were observed from 1995-2001, although the situation remained uncertain. The capacity of industrial plants in Kutaisi was extremely low. Industry gradually lost its dominant position in the city's economy over the decades that followed, and along with a transition to the market economy this lead to basic changes in economic structures. The main activity shifted to the service sectors and today the industry sector represents only 17% of production output. Commerce and trade occupy 36,5% of the economy; education, healthcare and sport are 7,5%, and the construction sector is 12%. (**Error! Reference source not found.**). Finally in 2012 there was a tangible mprovement of production volume and of the total turnover since 2002.

The number of registered businesses also indicates increased financial activity. For example, in 2009 17,452 businesses were registered and by 2011 there were 24,860. Increased business activity had a positive impact on employment. In 2009, 33,271 persons were employed, while in 2011 there were 36 747. Positive changes in the industrial sector and concrete steps to liberalize the economic course of the country had positive impacts on the following indicators:

From 2009-2011:

- Value added increased by 49% (from 610,4 million GEL to 911,7 million GEL)
- Business production increased by 41% (from 472,6 million GEL to 666,3 million GEL)

[4]Source: Kutaisi City Hall

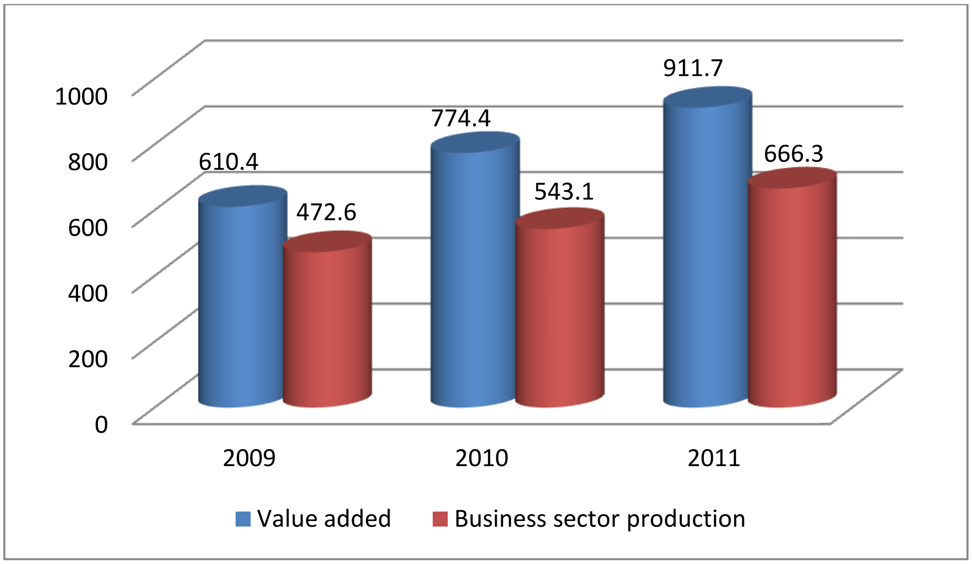


Fig. 3. Kutaisi industrial activity in 2010-2011(million GEL)[5]

The increases shown in Fig. 3 are mainly due to small factories and SMEs.

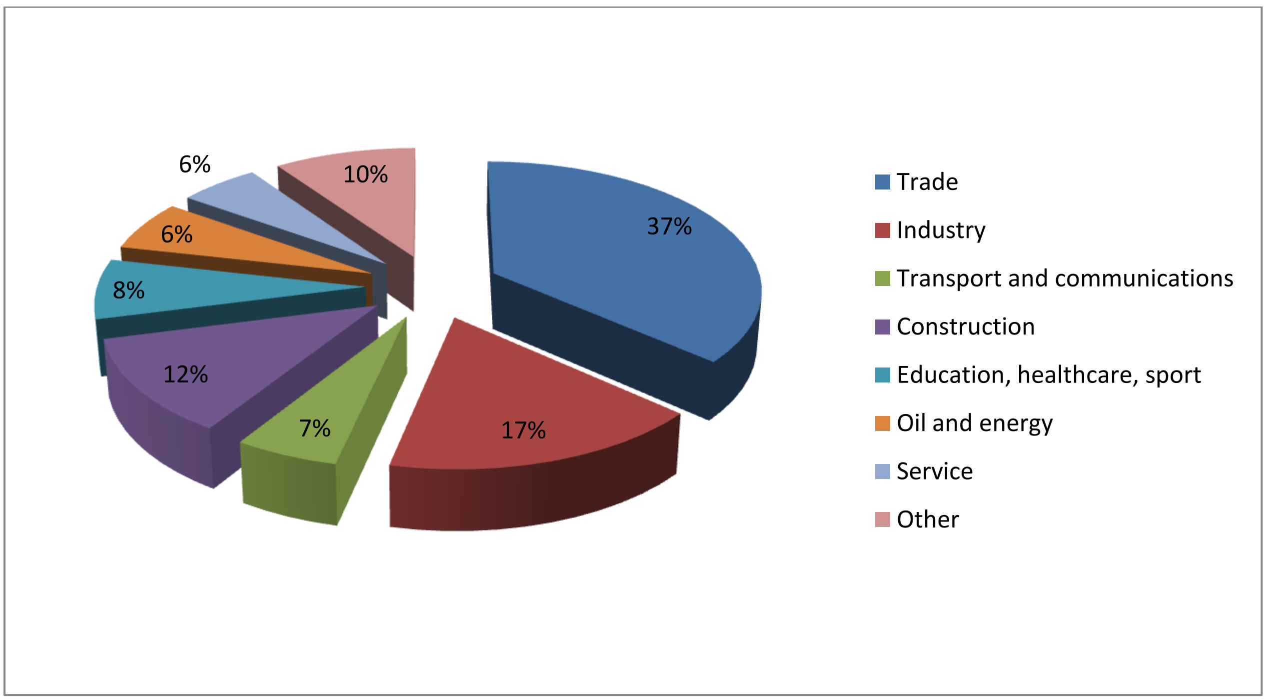


Fig. 4. Composition of economy sectors of Kutaisi, %

Among the new economic sectors, tourism has emerged as potentially important. A tourism development program aimed to brand Kutaisi as the touristic center of the Imereti region has been developed with the support of foreign experts. The city is surrounded by over 500 unique historical and cultural monuments and various mineral springs. Adventure travel and cultural tourism has become increasingly popular, given that the region abounds in 250,000 of

[5]Source: Kutaisi City Hall

mountains and woodlands. This and its rich historical heritage are exceptional opportunities for tourism. Initiatives in eco-tourism, rafting on the Rioni River, mountain hiking, horseback riding and speleo-tourism have already taken root.

A clean environment is an essential precondition for the development of tourism. It adds more value to the development and implementation of the Sustainable Energy Action Plan. The city's environment and energy efficiency is very important—for the local population and for tourism development. In order to turn Kutaisi into a city that is conducive for living and developing tourism, the service sector must develop. There are almost 20 restaurants, private hotels and dozens of cafés, bars and catering services. Up to a thousand trade and service centers, retail and wholesale markets, agricultural markets and large modern trade centers do business in Kutaisi.

The city infrastructure, including the state of the roads, has significantly improved in the last several years. The rehabilitation of water and sewage systems is ongoing, supported by European Bank for Reconstruction and Development (EBRD), the Swedish International Development Cooperation Agency (SIDA) and the Millennium Project. Most of the city is now supplied with natural gas, while electricity is available to all.

Measures undertaken in recent years have improved the image of Kutaisi, its infrastructure and industrial activities, which are the basis for its gradual transformation into a modern, well developed city. According to the Country Basic Data and Directions (BDD) document, the priority document for Kutaisi's development is a medium term action plan. This priority document recognizes that many citizens still live in difficult social conditions, and this is why the following tasks have been identified as main goals for the next 5-year period (from 2013-2018):

- Stabilization of the business sector and rapid development of SME sectors;
- Well-ordered infrastructure;
- Reduction of unemployment;
- Further improvement of investment environment.

Specific action has been identified for the period of 2013-2017:

- Infrastructure projects and programs (lighting, water supply, public gardens, parks);
- Support to small and medium size business;
- Development of modern municipal transport;
- Support for tourism development;
- Educational programs;
- Healthcare and insurance;
- Social projects;
- Sports and cultural programs.

Almost all projects/measures related to these priorities will directly or indirectly influence the sustainable development of the city's energy sector, and should thus be taken into consideration while planning.

Sustainable Energy Strategy

The main goal of the Sustainable Energy Action Plan is to reduce CO_2 emissions caused by energy consumption in Kutaisi. Simultaneously natural resources must be developed and diversified-- such as existing city parks, public gardens, and green areas-- to absorb emissions,.

It is essential to ensure the preservation of the cultural and historical heritage of the city while carrying out a Sustainable Energy Action Plan. This demands the involvement of all interested stakeholders, including the private sector, state, municipal authorities and local citizens into planning and implementation. While introducing low carbon technologies to the energy consumption sector, it is necessary to increase public awareness and motivate behavioral change in consumption patterns.

At the current stage, the Kutaisi SEAP is considering three main sectors related to greenhouse gas emissions: transport, buildings and infrastructures (landfills, outdoor lighting) and green spaces.

The Kutaisi Sustainable Energy Action Plan was prepared in 2014 and covers a six-year period until 2020. The emission reduction strategy defines measures in each sector for the short term (2014-2017) and for the long term (2018-2020). Measures defined for the short term are tangible and detailed, while those for the long term are more strategic and need additional investigation, planning and feasibility studies. These goals comply with the guidelines for the development of a SEAP.

Within the framework of the Kutaisi SEAP, a strategy for each sector has been developed based on the inventory data of emissions for a base-year, 2012, and CO_2 emission growth rates from 2012 until 2020. As a result, the following directions have been identified:

Transport Sector:

Measures considered for public transport development in the short-term strategy:

- Improvement of public transport services:
    - Elaborate optimal schemes for regular local routes within the city;
    - Introduce modern payment systems for public transport;
    - Develop an automatic system for public transport management;
    - Install electronic information boards at bus stops;
    - Create public transport promotion campaigns, to increase awareness and promote behavioral change.

To achieve these goals a detailed public transport strategy will be developed to define activities that can improve service quality and increase the attractiveness of municipal transport. Additional transport measures are foreseen:

- Upgrade and renovate fleet; at the first stage the fleet will consist of 70-80 new Bogdan type buses for 20-30 passengers, equipped with GPRS system.
- Establish an efficient municipal transport enterprise.

Measures, considered for public transport development in long-term strategy:

- Transform the municipal motor transport fleet to bio-diesel, which will be produced from used cooking oils collected from restaurants and hotels;
- Introduce fast public transport service that includes:
    - Arrange a tramline system on Nikea street, covering the whole street (5.5 km single direction segment) up to the by-pass road;
    - Provide Bus Rapid Transites (BRT) for central routes, ensuring fast and safe transportation.

Measures, considered for private transport development in the short-term strategy:

Construction, rehabilitation and maintenance of road infrastructure that include the following:

- Maintain existing renovated central roads, and rehabilitate new/minor roads and inner roadways;
- Install new traffic lights for improving safety and better traffic management;
- Construct a Kutaisi by-pass road, and adjust the entire road system accordingly.

Measures considered for private transport development in the long-term strategy:

- Develop pedestrian and bicycle routes, including public education on safety;
- Elaborate and enforce relevant parking policy with the introduction of parking fees and restricted parking in central districts of the city;
- Facilitate the development of standards for fuel quality and maintenance checkups.

Building Sector:

The short-term strategy of Kutaisi identifies several measures to be carried out to reduce greenhouse gas emissions from municipal and residential buildings and to decrease the consumption of energy resources. These include the use of energy efficient electric light bulbs, improvement of thermo-insulation of roofs, entrances, and common areas, repairing or replacing roofs, windows, and doors to avoid significant heat loss. These measures are advantageous in terms of affordability.

Transition to energy-efficient lights implies replacing incandescent bulbs with compact fluorescent (CFL), light-emitting diode (LED) or halogen bulbs that which are more feasible in the longer term, considering their price, energy consumption and lifecycle. Education campaigns will raise the public awareness and acceptance rate.

Using renewable energy sources is one of the most effective ways to reduce carbon dioxide emissions. Energy resources in buildings are mainly consumed for heating and hot water. Using biomass and solar energy would significantly decrease the consumption of natural gas. This will reduce carbon dioxide emissions. Even if these measures are implemented in only 16% of private homes, the city's CO_2 emissions would be reduced by 20%.

Considering these possibilities, the long-term strategy of Kutaisi on GHG emissions includes producng residual biomass briquettes for use in local heating systems, as well as the installation of solar collecting panels in municipal and residential buildings. This will not only supply hot water and heating, but will clear the path towards non-traditional renewable energy to the heat supply sector.

Measures considered for the Kutaisi building sector within the framework of the short- and long-term strategies:

2014-2017

- Transition to energy-efficient lights;
- Roof insulation for day care centers and kindergartens;
- Installation of energy-efficient lighting in areas of common use in residential buildings;
- Thermal insulation of common areas and entrances to residential buildings;
- Heat insulation of roofs in private homes;
- Energy -efficient affordable housing for refugees (pilot project);
- Program for thermal insulation and roofing for 41 vulnerable families.

2018-2010

- Installation of solar panels for hot water supply in private homes (investor);
- Use of pallets and briquettes made of wood biomass in municipal and private buildings (pilot projects);
- Use of solar energy panels in day care centers and kindergartens.

Municipal Infrastructure Sector

The Municipal infrastructure Development Strategy includes three sub-sectors: collecting and burning methane (CH4) from municipal landfills (long term); increasing energy efficiency in the street lighting sector (gradually during the whole period); and increasing green spaces in the city. The greening measures are defined as tree planting in recreation zones; greening of the city street curbs (short term); and planting recreational forest stands in the Botanical Garden (long term).

Summary of the Sustainable Energy Action Plan (SEAP):

The methodology for the development of Kutaisi's SEAP does not use the "fixed basic year", which implies high risks and can hinder cities in their efforts to comply with their obligations. The method used took into consideration the normal development perspectives of the country and the city. Emissions (caused by an increased demand on energy carriers) may increase by 2020, which is a traditional development scenario (BAU). The SEAP offers different measures and project proposals for reducing emissions compared to the traditional scenario. A more detailed description of the methodology for the BAU scenario is found in the chapter on Transport.

Summarized inventory data for 2012 and 2020 and assessment of the reduced emissions after carrying out the measures reflected in the Sustainable Energy Action Plan are given below, in Table 2 and Table 3.

Table 2. Greenhouse gas emissions in Kutaisi in 2012 and 2020 (t CO_2 eq)

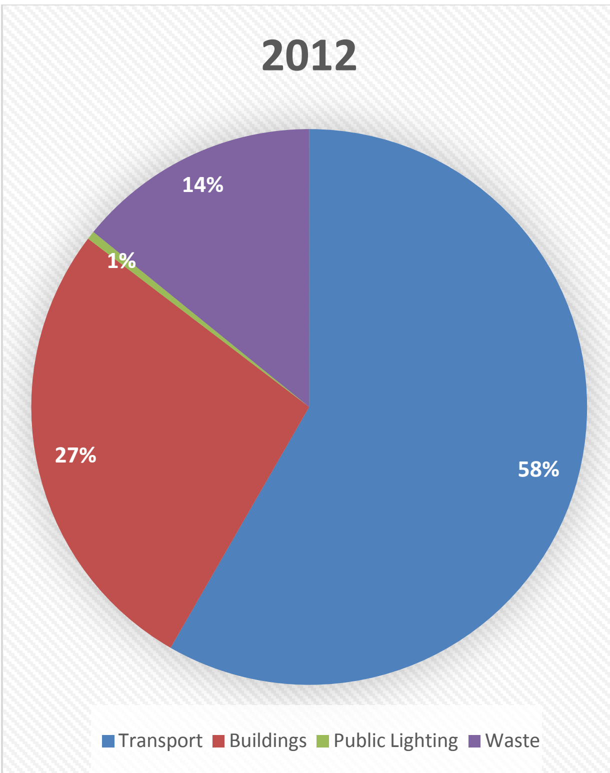
Sector	2012	2020 (BAU)
Transport	152,252	262,069
Buildings	70,606	145,693
Street lighting	1,280	1,604
Waste	36,960	28,350
Total	**261,098**	**437,717**

Table 3. Emissions reduced according to the Kutaisi Sustainable Energy Action Plan

Sector	Reduction (t CO2 eq)
Transport	43,548
Buildings	30,300

Street lighting	911
Waste	25,192
Greening	178
Total	**100,128**

Fig. 5 shows the distribution of emissions according to sectors in base year of 2012 and in 2020 with BAU scenario. Increased emissions in different sectors for the BAU and the SEAP scenarios are shown in Fig. 6 - Fig. 9.



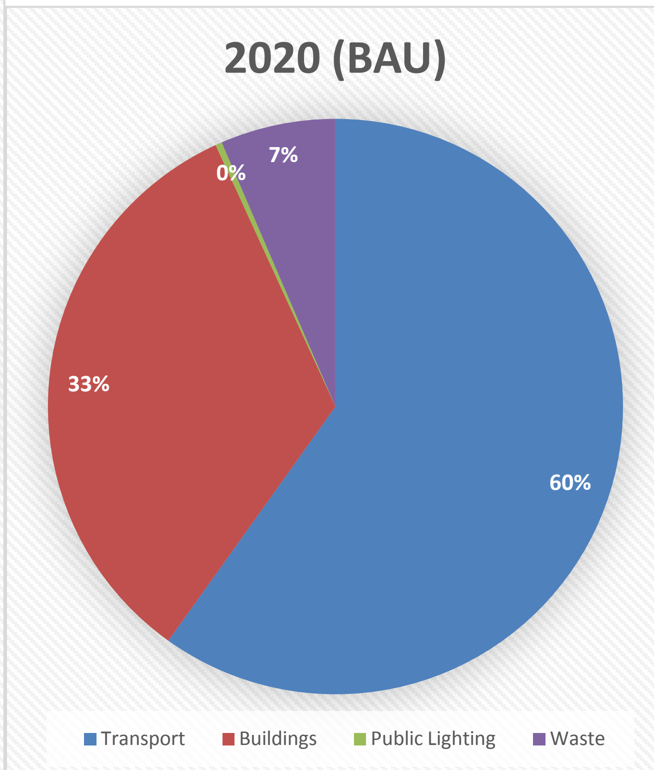


Fig. 5. Emissions distribution according to sectors in 2012 and 2020

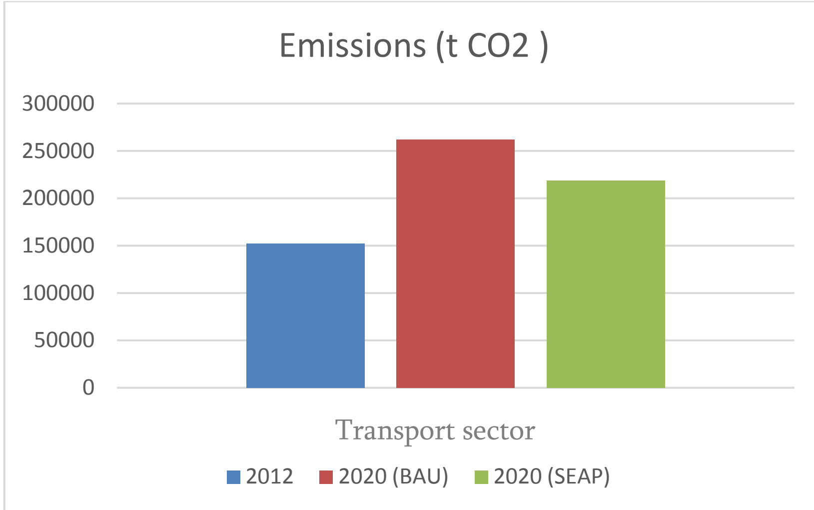


Fig. 6. Emissions in BAU and SEAP scenarios in Transport sector

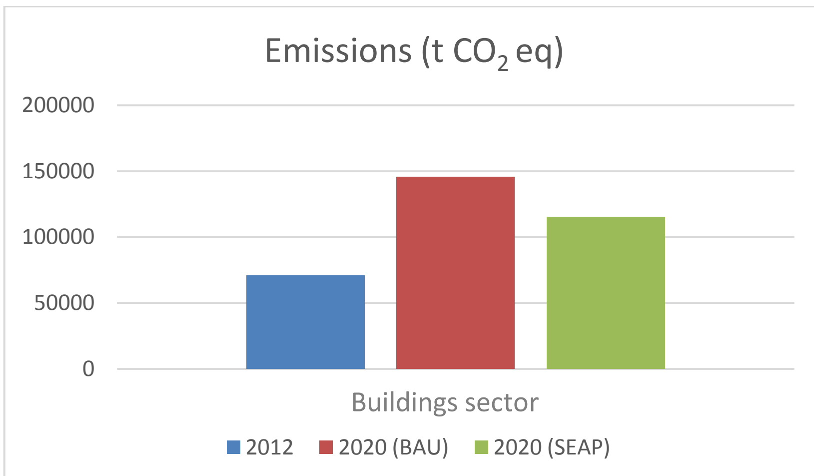


Fig. 7. Emissions in BAU and SEAP scenarios in Buildings sector

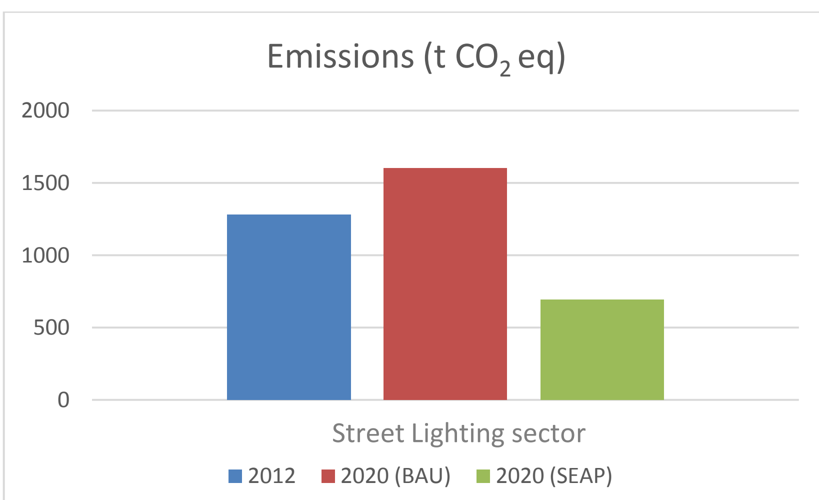


Fig. 8. Emissions in BAU and SEAP scenarios in Street Lighting sector

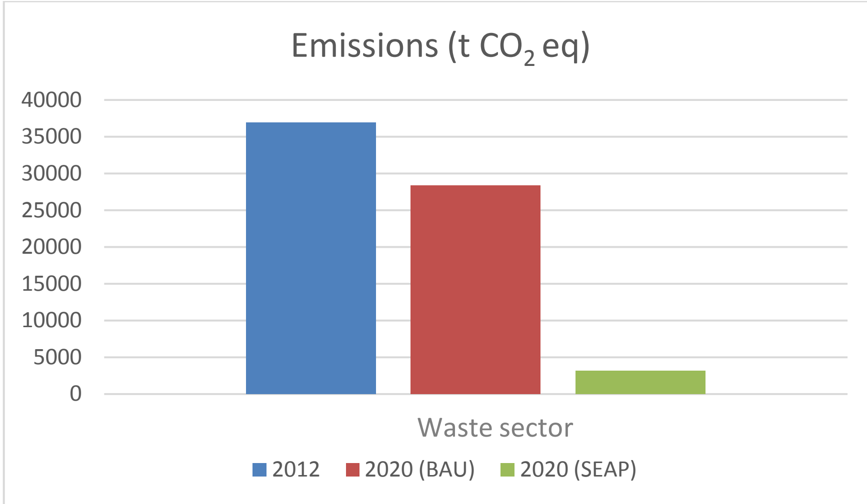


Fig. 9. Emissions in BAU and SEAP scenarios in Waste sector

Transport and Road Infrastructures

Sector overview

Among the public functions of Georgia, transit a very crucial role. Because of its geopolitical location, Kutaisi became an important part of the transport corridor between Europe and Asia as well as between east and west Georgia. As a key element in this corridor, Kutaisi has experienced an increase of traffic and related emissions. Therefore, the Zestaponi – Kutaisi –Samtredia highway which is currently under construction, is particularly important. One of the most significant parts of this highway will be Kutaisi's bypass road. When it is finished transit traffic will be redirected from the city territory to the highway.

Fig. 10. shows Kutaisi's layout. City roads are 414 longitudinal kilometers, including 78 km of road bends and deadends. Of the 336 km of main roads, 44% is asphalted.

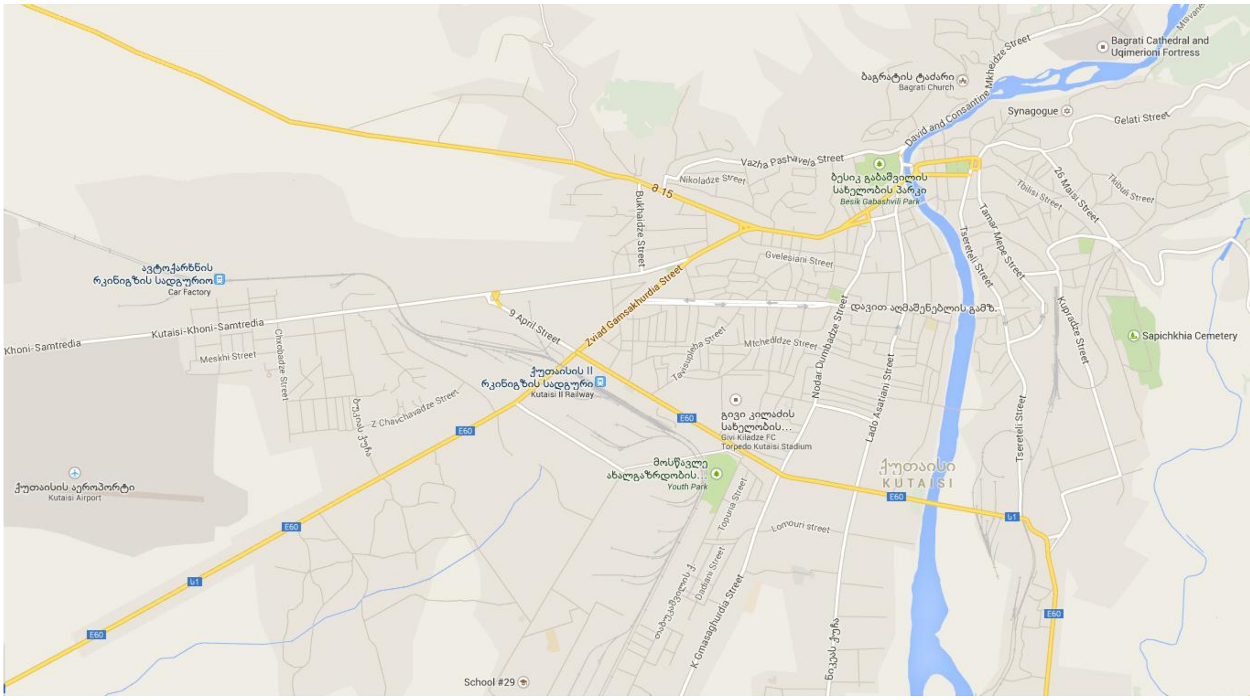


Fig. 10. Kutaisi layout

The city's road infrastructure is almost entirely in disrepair, including thoroughly rehabilitated roads--most need fundamental reconstruction. Poor road conditions hamper traffic and increase CO_2 emissions. Considerable funds are spent annually from the city budget for road construction and pavement rehabilitation. Between 2008 and 2012, 225,100 m^2 of asphalt was laid, which cost 18.9 million GEL, with an additional 230,000 GEL spent on bridge repair. Water sewers and sidewalks were also repaired on some streets.

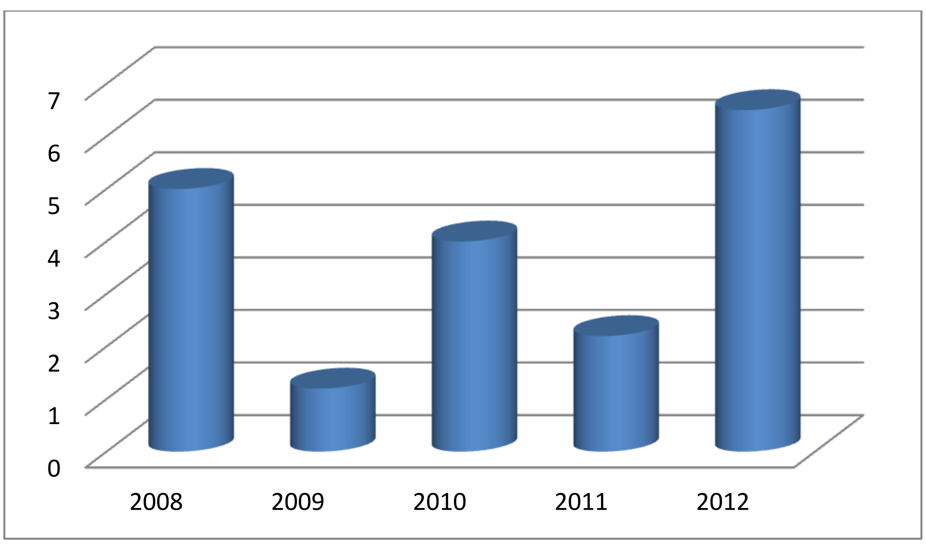


Fig. 11. Amounts spent on Kutaisi road rehabilitation (million GEL)

The situation is better concerning traffic lights. There are 29 well-functioning traffic lights in the city, enough to ensure the uninterrupted flow of traffic. In 2014, the Regional Development and Municipal Development Funds

(RDF, MDF) from Kutaisi City Hall received 130 projects for road infrastructure improvements. The funders's decisions are not yet known.

Population dynamics and the increased number of employed persons have meant a greater demand for public transport and higher need to plan new routes. Currently approximately 32 million passengers are carried by public transport annually. This number is expected to rise, along with inceased emissions due to additional vehicles. This means that energy efficiency in the transport sector is one of the most crucial tasks for sustainable energy development.

Until 2007, the population of Kutaisi was served by a municipal transport enterprise, which was shut down due to its outdated vehicles. Private transportation companies were given permits for regular city routes. Currently there are 12 active companies, which complicates the timely and proper management of energy efficiency measures, and may require additional control mechanisms. Since a transport service control group is already responsible for monitoring permits and violations, it would be reasonable that they monitor energy efficiency measures. The main violations identified by the control group at present include violation of traffic schedules, arbitrary stops and the insufficient number of vehicles, especially at night. These problems have a negative impact on the popularity of public transport and make private vehicles more attractive to use. Restoring municipal transport must be considered as an effective measure, among others, to decrease CO2 emissions.

Table 4 shows the types of vehicles registered in Kutaisi, as well as the quantity and type of fuel consumption for 2012.

Table 4. Transport Registered in Kutaisi and their Characteristics

Vehicles	Cars (excluding taxis and municipal vehicles)	Kutaisi Municipality Service and other Vehicles	Buses	Minibuses	Taxis	Light Trucks (up to 2 ton capacity)	Medium and Heavy Trucks
According to Fuel							
Gasoline powered	31,121	45			93	217	
Diesel powered	7,836	8	194	587	121	1,208	853
Natural-gas powered	6,348				479		
Sum	**45,305**	**53**	**194**	**587**	**693**	**1, 425**	**853**
Annual mileage (km/vehicle)	9000	8000	40,000	60,000	50,000	30,000	15,000
Average fuel consumption of gasoline (l/100 km)	10.00	8.00			10	16	
Average fuel consumption of diesel (l/100 km)	8.00	35.00	38	15	9	14	30
Average fuel consumption of natural gas (cub. m/100 km)	10.00				11		
Total gasoline consumption (liter)	28,008,900	28,800	1280	0	465,000	1,041,600	
Total diesel consumption (liter)	5,641,920	22,400	2,948,800	5,283,000	544,500	5,073,600	3,838,500
Total natural gas consumption (cub. m.)	5,713,200				2,634,500		

Table 5 shows public transport vehicles serving the city. In terms of energy efficiency, permits issued for city bus routes include an obligation to replace vehicles with new and technically improved buses one year after issuing the permit. The public minibus fleet has been upgraded and currently consists of vehicles manufactured from 2000 - 2006.

Table 5. Public transport of Kutaisi

	Working Daily	Inventory Quantity
Bus	67	97
Minibus	153	321
Sum	225	428

According to Table 4, total fuel consumption in Kutaisi reached almost 30 million liters of gasoline, 23.4 million liters of diesel and 8.3 m^3 of gas. Not all vehicles described in Table 5 run routes within the city limits, e.g. some buses and minibuses work intercity, but due to a lack of accurate information, including transit flows, the GHG inventory was still based on Table 4 data.

Methodology

The baseline year for the transport sector is 2012. GHG emissions are calculated by a formula adapted for the intergovernmental council's (IPCC) methodology level 1 sector approach for the local level, which is based on actual fuel consumption data.

Carbon Dioxide emissions $_j$ ($GgCO_2$)=

□$_i${actual fuel consumption $_{ji}$ (unit)x caloric value of fuel$_i$(MWh[6]/per unit)

x carbon emissions factor (TC/MWh)/1000x oxidized carbon share i}x 44/12,

Where lower index refers to sector and lower index *i* - type of fuel.

Emissions for other gases with the sector approach were calculated with the following formula:

Greenhouse gas emissions $_j$ (GgGas)=

□$_i${Actual fuel consumption $_{ji}$ (unit)

x caloric value of fuel$_i$(MWh/per unit)

x gas emissions factor $_{ji}$(TGas/MWh)/1000].

IPCC typical values of carbon emission factors (carbon emission per energy unit) and transfer coefficient (fuel's combustion heat, i.e. caloricity) have been used for calculations since 1996.

[6]The basic energy unit in IPCC methodology is the terajoule, while according to the SEAP methodology it is MW/h. That is why MW/h is used here.

Table 6. Transfer Coefficients and Carbon Emission Factors for Different Types of Fuel

Type of Fuel	Unit	Transfer Coefficient (MW/h unit)	Carbon Emission Factor (Ton C/ MW/h)
Gasoline	1000 liters	0.01	0.247
Diesel	1000 tons	0.011	0.267
Liquid Gas	1000 tons	0.013	0.227
Natural Gas	1 million m^3	0.009	0.202
Firewood	1000 m^3	0.002	--

The Average emission factor of grid electricity was used in 2012--0.136 kg CO_2/kWh for electric power.

A small portion of carbon in fuel is not oxidized during combustion but most is oxidized later in the atmosphere. Non-oxidized carbon is stored for indefinite periods. Typical values of oxidized carbon recommended by IPCC and used in the 2006-2011 inventory are provided inTable 7.

Table 7. Share of Oxidized Carbon for Different Fuels

Fuel	Share of Oxidized Carbon
Oil and Oil Products	0.990
Natural Gas	0.995

Different gas emission factors for transport sector are given in Table 8.

Table 8. Methane and Nitrous Oxide Emission Factors for Transport Sectors (kg/MWh)

Greenhouse Gas	Gasoline	Diesel	Natural Gas
CH_4	0.072	0.018	0.18
N_2O	0.002	0.002	0.0004

Global warming potential values (GWP) of gases are used to convert methane and nitrous oxide into carbon dioxide equivalents.

Table 9. Global Warming Potential of Methane and Nitrous Oxide

Gas	Life Expectancy, Years	100-year GWP
CH_4	12±3	21
N_2O	120	310

A Guidance document[7] has been developed by the Joint Research Centre (JRC) especially for the Eastern Partnership member cities so that they can choose mandatory reductions of emissions through three alternative approaches:

1. Reduction for full emissions of a fixed base year;
2. Per capita emissions reduction for fixed year emissions;
3. Reductions by BAU scenario for prospective emissions of 2020.

The sustainable energy development plan of Kutaisi uses the emissions reduction calculations for the BAU scenario. The Guidance doucment describes two possible versions to construct a scenario:

1. The city can develop its own methodology which will be evaluated later by the JRC.
2. The city may use national ratios indicated in the Guidance document, which were developed for the Global Atmosphere Research (EDGAR) project CIRCE[8] employing an emissions database. The POLES (Prospective Outlook for the Long-term Energy Systems)[9] method has also been used, which considers the growth of energy consumption due to population and economic growth. According to the baseline year, the BAU scenario calculates level of emissions for 2020 assuming that current population, economy, technology and human behavior trends will continue, and that no national measures will be taken towards a reduction of emissions.

The first approach has been used in case of Kutaisi, i.e. its own methodology has been developed that was similar to the second approach. As in the second approach, national growth ratios are being used, with the following differences:

1. The ratios have not been obtained from from research conducted outside the country, like JRC ratios, but they have been extracted from the BAU scenario results, based on a MARKAL-

[7]"HOW TO DEVELOP A SUSTAINABLE ENERGY ACTION PLAN (SEAP) IN THE EASTERN PARTNERSHIP AND CENTRAL ASIAN CITIES" – GUIDEBOOK, European Commission Joint Research Centre, Institute for Energy and Transport, Luxembourg: Publications Office of the European Union © European Union, 2013

[8] U.M. Doering, G. Janssens-Maenhout, J.A. van Aardenne, V. Pagliari (2010), CIRCE report D.3.3.1, Climate Change and Impact Research in the Mediterranean Environment: Scenarios of Future Climate Change IES report 62957.
- A. Pozzer, P. Zimmermann, U.M. Doering, J. van Aardenne, H. Tost, F. Dentener, G. Janssens- Maenhout, and J. Lelieveld, Effects of business-as-usual anthropogenic emissions on air quality, Atmos. Chem. Phys. Discuss., 12, 8617-8676, 2012, doi:10.5194/acpd-12-8617-2012

[9]Russ, P., Wiesenthal, T., van Regenmorter, D., Ciscar, J. C., 2007. Global Climate Policy Scenarios for 2030 and beyond. Analysis of Greenhouse Gas Emission Reduction Pathway Scenarios with the POLES and GEM-E3 models, JRC Reference report EUR 23032 EN. http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=1510

Georgia model. This was created on the National level and used for calculating low-emission development and energy development strategies for Georgia. Therefore, these ratios better reflect the current situation and future plans of the country.
2. The ratios are available at the level of total emissions as well as at different fuel consumption levels in various sectors, which allows better planning of mitigation measures.
3. If there are population and Gross Domestic Product (GDP) growth projections at municipal level, mentioned projections may be used for modification of MARKAL-Georgia national ratios.

Using this method, a small, Excel-based software program, muni-EIPMP (municipal emissions' inventory, projection and mitigation measures planning), was developed by the USAID funded "Enhancing Capacity for Low-Emission Development Strategies Clean Energy Program", on which the BAU scenario projections were based, acquired on the basis of MARKAL-Georgia model, and can be adapted to specific municipality inventories. The BAU scenario has been developed for Kutaisi via this software. Ratios used are shown in Table 13.

In addition to greenhouse gases, other transport fuel pollutants have been identified. The software COPERT IV (Computer Programme to Calculate Emissions from Road Transport) created by the European Agency is widely used in Europe and has been used here. Information in Georgia and its regions mainly need adaptation to the COPERT IV model, since a substantial part of this information does not exist. COPERT IV, on the basis of standard values of properly selected initial data, allows an approximate evaluation of emissions. Due to the lack of technical inspections for vehicles and information on fuel quality, the true values of pollutant emissions are likely much higher those shown here. As for the number of vehicles and consumed fuel, they are tailored to specific locations. The use of COPERT makes it possible to regulate database and create the precondition to calculate emissions from transport sector and fully exploit the software. It will be necessary to include certain other categories while collecting data. These results can be used to see emission trends, and to determine which are most likely to increase and which will be reduced as a result of measures taken.

The following pollutants have been assessed through the COPERT:

- Heavy metals: Lead (Pb), Cadmium, Copper, Chromium, Nickel, Selenium, Zinc;
- Volatiles: Volatile Organic Compounds (VOC), Non-methane Volatile Organic Compounds (NMVOC);
- Non-volatiles: Carbon Monoxide (CO), Nitrogen Oxides (NOX, NO, NO2, NH3), PM, OM, EC, FC.

Direct GHG emissions have also been assessed (C02, N2O andCH4) for all vehicles registered in Kutaisi (see Table 4) and compared with the results of the inventory.

Base-Year Inventory and Greenhouse Gas Emissions Baseline Scenario (2013 - 2020)

The Kutaisi transport sector and base year inventory is based on 2012 data and includes the following kinds of transportation:

- Municipal service vehicles;
- Public transport (buses, mini-buses and taxis);

- Private and commercial transport.

According to the Sustainable Energy Plan Development Methodology, fuel consumption by navigation, air traffic and railway is not considered, since travel with these forms of transport are outside the territorial limits of the city. Fuel consumption in the transport sectorreached about 609,000 MWh in 2012.

Table 10. Final Energy Consumption of Kutaisi Transport Sector (MWh) - 2012

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	240.2	273.63	513.83
Public Transport	24 583.32	94 108.97	4 417.85	123 110.14
Private and Commercial Vehicles	53 312.75	156 065.24	276 015.78	485 393.77
Total	**77 896.07**	**250 414.41**	**280 707.26**	**609 017.73**

Emissions of greenhouse gases from the transport sector reached about 152.3 thousand tons of CO_2 equivalent in 2012.

Table 11. Greenhouse Gas Emissions from Kutaisi Transport Sector in CO_2 Equivalent - 2012

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	63.65	68.17	131.83
Public Transport	5035.29	24 938.88	1100.69	31,074.86
Private and Commercial Vehicles	10 919.81	41 357.29	68 768.47	121 045.56
Total	**15 955.09**	**66 359.82**	**69 937.33**	**152 252.25**

Emissions of other pollutants in 2010-2012 are shown inTable 12:

Table 12. Total Pollutants and Percentage Difference in 2010 - 2012

№	Title	Year			Difference between 2010 - 2012
		2010	2011	2012	
1	PB	0.02	0.02	0.02	**10%**
2	Cadmium	0.0005	0.0005	0.0008	**57%**
3	Copper	0.24	0.25	0.26	**9%**
4	Chromium	0.01	0.01	0.01	**9%**
5	Nickel	0	0	0	**8%**
6	Selenium	0	0	0	**7%**

7	Zinc	0.1	0.1	0.1	**8%**
8	VOC	1 213.71	1 237.68	1 251.48	**3%**
9	NMVOC	1 165.20	1 187.24	1 198.76	**3%**
10	CO	10 308.85	10 479.46	10 573.79	**3%**
11	CH4	48.53	50.4	51.41	**6%**
12	NOX	1 104.02	1 179.32	1 205.49	**9%**
13	NO	1 027.21	1 105.61	1 119.65	**9%**
14	NO2	75.97	83.47	86.45	**14%**
15	N2O	3.4	3.56	3.62	**6%**
16	NH3	1.77	1.79	1.88	**6%**
17	PM	46.28	50.37	51.74	**12%**
18	OM	14.92	16.24	16.58	**11%**
19	EC	21.63	23.71	24.26	**12%**
20	FC	45 995.98	48 834.00	49 812.38	**8%**
21	CO2	143 379.38	152 183.00	155 189.00	**8%**

Growth ratios of different fuel consumptions in the transport sector according to the MARKAL-Georgia National Model are given below:

Table 13. Fuel Consumption Growth Ratios of Different Transport Types according to the BAU Scenario

Year / Fuel	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passenger Cars									
Gasoline	1	1.06	1.11	1.17	1.25	1.32	1.4	1.47	1.53
Diesel	1	0.93	0.87	0.8	0.73	0.67	0.6	0.53	0.47
Gas	1	1.37	1.73	2.1	2.58	3.06	3.54	4.07	4.61
Municipal Transport (buses, mini-buses)									
Gasoline	1	0.92	0.83	0.75	0.67	0.58	0.5	0.42	0.33
Diesel	1	1.09	1.17	1.26	1.35	1.43	1.52	1.61	1.69
Gas	1	1.15	1.31	1.46	1.61	1.77	1.92	2.07	2.23
Heavy Trucks									
Gasoline	1	0.92	0.83	0.75	0.67	0.58	0.5	0.42	0.33
Diesel	1	1.16	1.33	1.49	1.69	1.9	2.1	2.28	2.46
Gas	1	0.92	0.83	0.75	0.67	0.58	0.5	0.42	0.33
Small Trucks									
Gasoline	1	0.92	0.83	0.75	0.67	0.58	0.5	0.42	0.33
Diesel	1	1.05	1.09	1.14	1.2	1.27	1.33	1.39	1.44
Gas	1	0.92	0.83	0.75	0.67	0.58	0.5	0.42	0.33

In the absence of local projections of gross domestic product and population growth, national projections without modifications have been used for Kutaisi. According to the baseline scenario, fuel consumption will increase by 80%, reaching about 1095 thousand MW/h for 2020.

Table 14. Final Energy Consumption in the Kutaisi Transport Sector (MW/h) - 2020

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	368.01	368.62	736.63
Public Transport	113 242.94	152 196.32	6 768.63	272 207.89
Private and Commercial Vehicles	245 579.64	165 908.47	411 001.65	822 489.76
Total	**358 822.58**	**318 472.80**	**418 138.90**	**1 095 434.28**

Greenhouse gas emissions from the transport sector reached about 262,000 tons of CO_2 equivalent by 2020 according to the same scenario.

Table 15. Greenhouse Gas Emissions of CO_2 equivalent from Kutaisi Transport Sector – 2020

Subsector	Natural Gas	Diesel	Gasoline	Total
Municipal Vehicle Fleet	0	97.52	91.84	189.36
Public Transport	23,195.03	40,332.03	1686.38	65,213.44
Private and Commercial Vehicles	50,300.95	43,965.74	102,399.77	196 666.47
Total	**73,495.98**	**84 395.29**	**104 178.00**	**262 069.27**

Growth of emissions in different subsectors of transport sectors are given below:

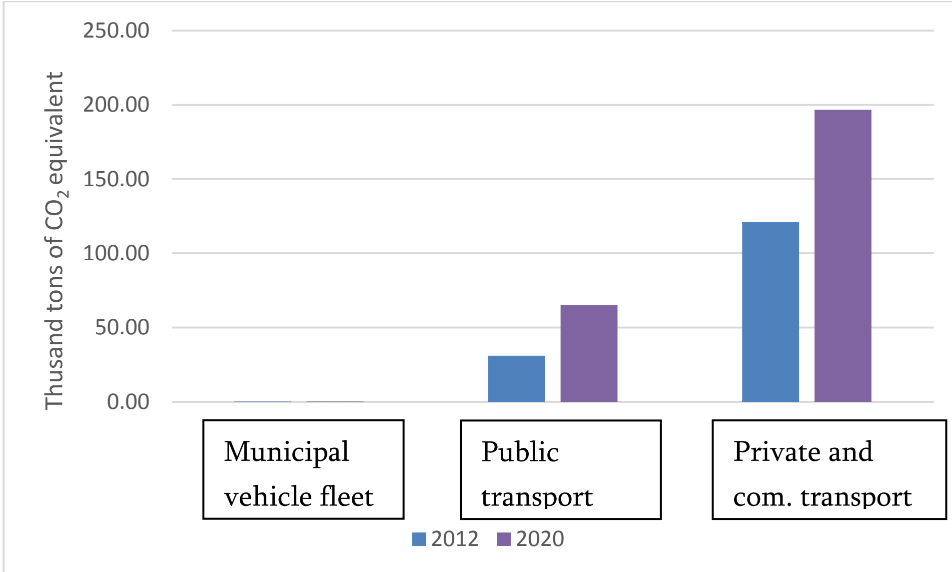


Fig. 12.Trends of Emissions from the Transport Sector according to the BAU Scenario

The following table shows values of local pollutants from vehicles, registered in Kutaisi

Table 16. Total Amount of Pollutants in Tons and Percentage Difference between 2010 – 2020

#	Title	Year								Difference between 2010 - 2020
		2013	2014	2015	2016	2017	2018	2019	2020	
1	Pb	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	**59%**
2	Cd	0.0006	0.0006	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008	**45%**
3	Cu	0.27	0.3	0.31	0.33	0.36	0.38	0.4	0.42	**53%**
4	Cr	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	**55%**
5	Ni	0.005	0.005	0.005	0.005	0.006	0.006	0.006	0.007	**46%**
6	Se	0.0006	0.0007	0.0007	0.0007	0.0008	0.0008	0.0009	0.0009	**41%**
7	Zn	0.11	0.12	0.12	0.13	0.14	0.15	0.16	0.17	**51%**
8	VOC	1 253.47	1 385.31	1 452.80	1 544.29	1 636.33	1 726.93	1 807.82	1 888.03	**51%**
9	NMVOC	1 199.28	1 326.11	1 389.52	1 475.98	1 562.77	1 648.55	1 724.52	1 799.94	**50%**
10	CO	10 565.84	11 708.64	12 279.93	13 058.53	13 841.24	14 613.50	15 299.61	15 981.22	**51%**
11	CH4	53.39	59.32	63.17	68.18	73.44	78.23	83.15	87.89	**65%**
12	NOX	1 244.30	1 343.94	1 422.73	1 509.25	1 595.99	1 680.74	1 759.91	1 836.38	**48%**
13	NO	1 153.58	1 250.96	1 320.23	1 400.87	1 481.74	1 560.69	1 634.34	1 705.58	**48%**
14	NO2	90.85	98.15	102.66	108.62	114.49	120.33	125.88	131.12	**44%**
15	N2O	3.77	4.16	4.43	4.75	5.08	5.39	5.68	5.97	**58%**

16	NH3	2.59	2.99	3.37	3.84	4.38	4.81	5.32	5.84	**125%**
17	PM	54.33	53.94	56.37	58.22	60.06	61.81	63.49	65.01	**20%**
18	CO2	17.39	17.32	17.64	18.04	18.44	18.82	19.16	19.44	**12%**
19	Pb	25.58	25.5	26.01	26.61	27.2	27.79	28.33	28.79	**13%**
20	Cd	52 554.33	57 455.03	60 858.23	65 393.43	70 075.78	74 416.65	78 855.60	83 204.75	**58%**
21	Cu	163 382.28	178 285.77	188 226.93	201 824.56	215 828.22	228 869.31	242 090.79	255 029.14	**56%**

Emission Reduction Action Plan from Kutaisi Transport Sector

Transport plays a key role in society. It takes people to workplace and school, shops and medical facilities. It delivers agricultural products to markets, raw materials to factories, office materials to organizations and finished products to shops. It bonds families and friends to socialize and help each other. It allows politicians and businessmen to establish direct contacts, solve problems and grow business relations. However, transport consumes significant amount of energy to operate, and today fossil fuels have been recognized as main producers of greenhouse gas emissions in the atmosphere. The world's environmental, social and economic challenges require switching to public transport--electric or other more sustainable private vehicles, walking using bicycles and carrying out better territorial planning.

The positions of various countries to overcome these challenges are different. In highly developed countries, overcoming the habit of dependence on cars can be attained, while developing countries are still trying to improvise the planning and use of public transport make it sector more sustainable. Developing countries often face serious traffic congestion, air pollution and insufficient quality of public transport infrastructure and services. The abundance of vehicles is not as acute in developing countries nowadays as in some developed ones, but fast economic growth in many countries with its corresponding increase in private vehicles requires that measures be taken. Poorly managed traffic, noise, lack of road security, air pollution and greenhouse gas emissions make developing cities less attractive for investors, causing them to take their business elsewhere.

Kutaisi, like other Georgian towns, lies between these two realities There are 230 privately owned cars per 1000 people, approximately half as many than in Western European cities. However there is an increase in the number of private vehicles in recent years and many in Georgia prefer large, inefficient vehicles thus, heavy traffic and air pollution caused by a lack of mandatory technical inspection, environmental information and fuel quality mean that most ignore issues of GHG. Therefore, an action plan on the reduction of GHG in the transport sector must primarily include improved traffic management, transport infrastructures and public transport services, then follow with restrictions for private vehicles and the deployment of more effective vehicles.

The SEAP of Kutaisi developed in 2014 covers six years, until 2020. Therefore, the emission reduction strategy for major sub-sectors (public and private) in the transport sector concerns two periods: the short–term (2014 – 2017) and long-term (2018 – 2020). Short-term measures are specific and detailed, while long-term ones are considered in terms of strategy and require additional research-planning and economic-technical justification. This approach is fully consistent with the guiding methodology of the SEAP.

The following action is being considered for public transport for the short-term strategy:

- Public transport service improvement:
  - Schematic plans for the optimal and regular local passenger transportation routes of the city;
  - Implement a modern payment system for the city transportation;
  - Create an automated system for public transport;
  - Implemen electronic information boards on public transport stops and their operating software;
  - Promote public transport services and carry out behavior change programs;
  - Develop a detailed public transport strategy to popularize public transport services.
- In addition, upgrade the transport fleet and created a municipal transport enterprise to include 70-80 new Bogdan buses with 20-30 passenger seats and GPRS system.

The following action is planned for a long-term public transport strategy:

Fast public transport services, which include:

- Build a tram system on 5.5 km of the one-way road from Nikea Street up to bypass road (highway) in Kutaisi;
- Create express bus routes (Bus Rapid Transit -BRT) for central routes, ensuring quick and safe bus transit;
- Convert some of the municipal transport fleet to biodiesel made from used cooking oil from restaurants and hotels.

In order to influence the private transport sector, both implementation of land and urban planning measures and scheduling the restrictions of high-emissions while encouraging low-emission activities are required. These should be carried out through joint efforts between state agencies. Among the priority projects planned for 2014-2017, the construction-rehabilitation of road infrastructures and the development of transport infrastructures are especially important.

The long-term strategy, in turn, combines measures aiming to decrease the interest in using private cars for city transportation, and the promotion of low-emission public transport use. Considering the fact that GHG emissions per passenger from private vehicles are significantly higher than forpublic transport, a reduction of private car usage and their replacement with public transport is especially important. Such an approach would enable the city to attract more tourists as well as more residents, as overcrowded streets have become a chronic problem for Kutaisi's health and economy. A transition from private cars to public transportation will significantly reduce overall traffic and make the city 'transport-friendly'. Therefore, the action plan of Kutaisi includes measures that might not reduce private car use, but will slow its growth and enable a cleaner transport sector to achieve the strategic goals. Measures to limit the use of private vehicles will be effective when other types of transportation become attractive and well developed, comfortable and available for all. These measures are part of the wider transport strategy and need further elaboration.

The following action is being considered for both public and private transportation in the short-term strategy:

- Road infrastructure rehabilitation and maintenance, including the following activities:
- Maintain existing rehabilitated central roads of the city and repair new/secondary, inter-neighborhood roads; streets and holes repaired;
- Install new traffic lights for better traffic management and safety;

- Construct Kutaisi bypass highway and adjust the city road system to this highway.

The long-term strategy for the private and public transportation includes the following:

- Develop walking and cycling routes while instigating public awareness programs;
- Conduct parking policies, setting prices and restricting parking in central districts of the city;
- Work out technical inspections and fuel quality standards for private vehicles.

A feasibility study to determinte the effectiveness of each measure will be carried out before implementation.

Carrying out the Sustainable Energy Action Plan of Kutaisi, will reduce CO_2 emissions from the transport sector by 43, 548 tons of CO_2 equivalent by 2020.

Transport Sector Action Plan of Kutaisi

Sectors and Activity Fields	Main Activities per Sector	Department/Person or Company in Charge/ if the third party is involved	Start/End Date	Cost	Expected Energy Savings (MW/h) from an Activity	Expected CO2 Emission Reduction from an Activity (T)
Transportation total					**88 892**	**43 548**
Public Transport	T1 Activity: Improving Public Transport Services T1.1. Optimal Transportation Scheming of Regular Local Passenger Transportation Routes of the City T1.2 Implement Modern Payment System in the City Transport T1.3. Develop Urban Transport Management Automated System in Kutaisi T1.4. Implement Electronic Information Devices and Operation Software at Urban Transport Stops T1.5. Public Transport Promotion and Behavior Change Programs	Kutaisi City Hall Transportation Service	2014-2017	5,000,000 USD	34,054	7968
	T2 Activity : Municipal Transport Upgrade	Kutaisi City Hall Transportation Service	2014-2017	Estimation needed	82	22
	T3 Activity : Municipal Transport Conversion to Biodiesel	Kutaisi City Hall Transportation Service	2018-2020	70,000 GEL		29
	T4 Activity: Rapid Public Transport Service Activities	Kutaisi City Hall Transportation Service	2018-2020	Estimation needed	43,801	10,249

	T4.1: Tram System Development T4.2: Bus Rapid Transit System Development					
Private and Commercial Transport	T5 Activity: Construction-Rehabilitation of the Road Infrastructure and Transport Infrastructure Development	Kutaisi City Hall Infrastructure Service, Ministry of Regional Development and Infrastructure	2014-2017	Estimation needed	10,954	2621
	T6 Activity. Development of Walking, Cycling Routes	Kutaisi City Hall	2018-2020	Estimation needed	8539	2721
	T7 Activity. Parking Policy Development	Kutaisi City Hall Transportation Service	2018-2020	Estimation needed	6811	1594
	T8 Technical Inspection and Fuel Quality Standards Elaborated	Government of Georgia, Kutaisi City Hall	2018-2020	Estimation needed	76,680	18,345

Description of Activities

T1 Activity - Public Transport Service Improvement and Popularization:

T1.1. Create an Optimal Transportation Plan for Local Passenger Transportation Routes

Due to a lack of passengers, the formation of direct transport links in Kutaisi between "Avtokarkhana Settlement - Sulkhan-Saba Settlement" ,"Avtokarkhana Settlement - Tabukashvili Street", "Sulkhan-Saba Settlement – Nikea Settlement", "Sulkhan-Saba Settlement – Tabukashvili Street", "Nikea Settlement – Tabukashvili Street" etc. via the existing routes of local regular passenger transportation has not been feasible. Therefore, only taxis and private vehicles serve these destinations. An increase in industrial and commercial activities in these settlements means they will become important industrial and commercial areas of the city, thus it is mandatory to review and modify existing transport routes and add new ones.

Relief to overcrowded traffic in Kutaisi's center and direct links between city districts will result in a reduction of transfers and travel time, better travel convenience, safety and reduced costs. It will improve traffic flow in the city center and increase environmental safety as well.

T1.2. Implement a Modern Payment System for City Transport

Currently users pay the fare directly to drivers in cash. This type of payment is inconvenient both for the driver and passenger, and doesn't permit any control of passenger numbers, nor sums taken by the drivers. It increases the number of times buses make stops (interrupting traffic), doesn't permit scheduled service and causes safety risks. Because of the direct payment system, drivers cannot adequately control passengers' safety when boarding and getting off. A modern electronic ticketing system is necessary for urban transportation.

An electronic fare payment system will permit revenue control by transferring information to a fleet management device installed in each vehicle, with a GPS positioning and vehicle tracking system and the possibility to transfer information via GSM to the main server of the Kutaisi City Hall Transport Office. After processing this information the development of a passenger flow parameter database will become possible, necessary for planning routes. This means that drivers will be less stressed, and concentrate only on road and passenger safety, as their schedules are more smoothly organized.

This means the public bus transport system will profit from clear schedules, the reduction of transportation time, a precise control of the number of passengers and revenue, increased safety and higher service quality.

T1.3. Develop an automated Urban Transport Management System in Kutaisi

Today the control of public transport is carried out by route dispatchers and transport service teams at main passenger gathering points. Proper tracking on all routes is impossible due to limited resources. An absence of control causes violations of traffic schedules, increased waits at the bus stops, loss of revenue and other disorders. Therefore, it is necessary to develop public transport GPS-supported automated dispatch software for distanced monitoring of vehicles. With GPS/GSM onboard devices and a remote monitoring system, tracking vehicles will become possible. This will help buses adhere to schedules, detect service interruptions and eliminate them. Data will then be available to track violations, take administrative action and create better organizational measures. It will mean the reduction or elimination of unauthorized stops and willful violations and better service schedules and passenger safety in boarding and disembarking.

T1.4. Implement Electronic Information Devices and their Operating Software at Public Transport Stops

Public transport stop amenities –modern design and construction equipped with electronic information displays—are already planned, and a bus stop project with international standards has been created by the transport service. Although the Kutaisi City Council approved the project in 2009, due to many changes in street names and addresses these modernization activities are only now being carried out. Modern bus stops have been installed on the main streets and the work must continue. They will be equipped with electronic information displays as there is no online system that provides information about bus routes and schedules.

The installation of electronic information displays at all public transport stops with operational software would provide information on routes, stops and intervals in two languages (Georgian and English). Including electronic displays in an on-line monitoring GPS/GSM system with remote control also allows passengers to access information on specific routes with their electronic devices. Access for the disabled to board buses is also being studied, using ramp/elevator systems. With improved services and technology, Kutaisi public transport will become more attractive and better able to serve residents and visitors.

T1.5. Promoting Public Transport and Changing Habits

Public transport has come to represent low social status, especially since services and technology have remained poor. Today many believe travelers on public transport cannot afford their own cars. In the developed world this view has changed, given the possibilities for more rapid arrival and comfortable conditions in public transport. In Georgia it will be necessary to advertise public transport more and inform them of the advantages. However, first they must be assured that public transport is reliable, fast, comfortable, safe, inexpensive and accessible. Once citizens understand the benefits of public transportation they will increasingly use it. Marketing and branding activities are important to show that public transportation has become more reliable and attractive. A marketing strategy should be developed so that traffic managers can identify the requirements of the users and raise the level of service quality. Sales promotion, advertising, networking, branding, product specification, claims management and customer service will contribute to the development of public transportation for the long term. Online information will allow passengers to access recent and detailed information on lines, routes, schedules and prices. Pamphlets including maps and instructions, should be distributed to all residents and to tourist offices and hotels, the Kutaisi airport, railway stations, travel agencies, cafes and restaurants and souvenir shops.

Improving public transport services and public awareness campaigns may not have a direct influence on energy consumption and CO_2 emissions, but they are valuable tools for supporting, accelerating and increasing the effectiveness of other activities. In developed countries, building awareness and changing behavior have reduced private car use by 10% --the return for every dollar spent is $30.[10] Since the share

[10] I Ker, Preliminary Evaluation of the Financial Impacts and Outcomes of the TravelSmart Individualised Marketing Program, ARRB for Department for Planning and Infrastructure, Perth, Western Australia, 2002.

of public resources for transport is relatively high in Georgia, as abroad, it is assumed that it will help reduce the rate of use of private cars by 10% before 2020. The transition from private cars to public transport will reduce emissions by half. [11] According to the baseline scenario, emissions from private vehicles with only one passenger in Kutaisi will reach 159,361 tons by 2020. If there is a 10% increase in the use of public transport, emissions can be reduced by half, or by 5%. This represents a 7968-ton reduction in CO_2 equivalent compared to the BAU. The total cost of implementing these activities, needed to improve public transportation, is $5,000,000.

Activity T2: Municipal Transport Upgrade

Initially the measure includes setting up of municipal transport enterprise equipped with 70-80 new 20-30 passenger Bogdan type buses, that will replace old buses and have about 10% improved efficiency.

Activity T3: Municipal Transport Conversion to Biodiesel

This measure implies the conversion of part of the municipal transport fleet to biodiesel. Biodiesel will be produced from used comestible oil collected from Kutaisi restaurants and hotels. In return, their ads will be put on buses. Ilia State University and the NGO Altera have launched a pilot project create a machine to make biodiesel-making fuel from waste cooking oil, which is being tested. A project proposal has been prepared. According to the proposal, ½-ton capacity biodiesel equipment can provide 15-20 buses with biodiesel that will save about 29,000 tons per year and costing nearly 70,000 GEL. To carry this measure out, a professional assessment of the comestible oil collection, storage and implementation will be required.

Activity T4: Fast Public Transport Service, considered within the long-term strategy, includes:

Activity T4.1: Tram System Development

The advantages of a modern tram compared to other means of transportation include:

- Safety (proven examples from many developed countries);
- Minimum amount of pollution and CO_2 emissions;
- Comfortable for elderly and disabled passengers;
- Large capacity – 3,000-15,000 passengers per hour in one direction;
- Average speed 25 – 30 km/h;
- Low energy consumption;
- Attractive for tourists.

The Sustainable Energy Action Plan involves a 5.5 km tramline from the beginning of Nikea Street up to a bypass road (highway) that will replace buses and minibuses. Marketing research conducted in Europe and 50-year North-American experience shows that private car owners prefer to replace their vehicles by

[11] Technologies for Climate Change Mitigation – Tranport Sector, UNEP Risoe Center, 2011. http://tech-action.org/

tramcars rather than by buses. According to statistics, 30-40% of tram passengers previously had their own cars.[12] .

Activity T4.2: Bus Rapid Transit – BRT Development

Bus Rapid Transit has become widely used in many countries for faster transportation of passengers in medium distances. It is possible to carry 10-20,000 passengers/hour with one BRT line. BRT lines have been successfully implemented in many cities including Bogota, Mexico City, Jakarta, Beijing, Istanbul, Paris, Los Angeles, Boston etc. Bus Rapid Transit systems are advantageous if the country/city government provides them separate lanes isolated from other vehicles and equips them with the necessary infrastructure (stops, shelters, information posters/displays).

According to the Mitigation Measures Manual for transport sector[13] trams use about 4,6 times less energy per passenger-kilometer than private cars, while buses consume 2.4 times less. Based on the conservative assumption if at least 3% of private car owners switch to trams and 7% to rapid buses this would reduce emissions by10,249 tons.

Activity T5: Construction-rehabilitation of Road Infrastructure and Transport Infrastructure Development. This activity plays an important role for priority projects from 2014 – 2017. Road infrastructure construction-rehabilitation and maintenance include:

- Maintain current rehabilitated central roads and rehabilitation of new/secondary and internal roads. Hole repairs and street rehabilitation;
- Install new traffic lights to organize traffic and ensure safety;
- Construct bypass road and adjust city transport system of Kutaisi to this road.

The construction of the bypass road will reduce transportation distances and therefore lower emissions. The measure would also relieve the congested traffic in the center. In general, lowering greenhouse gas emissions through traffic management (as well as road infrastructure improvement) is a complex and contradictory process. Reduced traffic overcrowding (through traffic lights, reserved bus lanes, etc) would lower greenhouse gas emissions from individual cars, as they would run more efficiently. However, this may not lead to overall emissions reduction since less congestion leads to the temptation of using private vehicles, which in turn increases emissions. One measure is to ensure fluidity and uniform velocity, which might be more effective than the "stop-start" mode of cars. Nevertheless, if this uniform motion leads to an increase in the number of vehicles, an increase in greenhouse gas emissions will be inevitable. Therefore, if reduced traffic is accompanied by limitations on private cars, a reduction of GHG emissions will be achieved. This is why these measures and associated emission reductions must be considered as part of the wider transport strategy. If all these measures are carried out, the annual energy consumption by transport can be reduced by 1% for 2020, implying a 2621 tons CO_2 equivalent reduction in emissions.

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[12]Sustainable Light Rail – Professor Lewis Lesley. Claverton Energy Group Conference, Bath October 2008, claverton-energy.com

[13] Technologies for Climate Change Mitigation – Tranport Sector, UNEP Risoe Center, 2011. http://tech-action.org/

Activity T6: Development of Pedestrian and Cycle Routes

The bicycle is one of the most popular modes of transport in the world, with 130 million bikes produced worldwide in 2007. In comparison only 69 million cars were manufactured during that period. Due to energy crisis and air pollutionin the 1970s, many European countries decided to promote more sustainable means of travel, including public transport, walking and cycling.

Barriers to a wider use of cycling can be overcome via following measures:

- Ensure safe bike routes;
- Include issue within other urban planning activities;
- Increase availability of bicycles as well as technical services and spare parts;
- Increase level of bicycle protection;
- Increase public awareness bike safety programs.

One example of promoting bicycle use is a race held in Kutaisi in Aghmashenebeli Ave. on the occasion of energy efficiency day from 21 to 27 June. Government representatives participated along with youth volunteer groups, local residents, students and the media.

A pedestrian area is also important, especially when combined with bicycle use. This combination of practices and technologies can enable the city to become safer and more functional in the future, while contributing to sustainability and socialization. It will increase the attractiveness of the city and contribute to healthier urban environment. Pedestrian areas have well-planned, well-connected networks, making it easier for residents to arrive safely, comfortably and on time. This measure also includes “environmental islands” where private cars are prohibited. A feasibility study should be prepared before the implementation of these measures to determine optimal cycling and pedestrian routes and the location of “environmental islands”.

According to the Mitigation Measures Manual for the Transport Sector[14], a two-kilometer walk or bike ride can reduce emissions by 417 grams. Germany, where the number of private vehicles is very high, reached the following goals: only 15% of 1-3 km distances are covered by cars, 55% of these short distances are made on foot and 30% by bike. According to a conservative assumption, at least 30% of 1-3 km distances in Kutaisi can be covered on foot or by bike by 2020. These short routes include about 5% of total movement. According to the baseline scenario, private passenger cars and public transport will cover nearly 870,000,000 km in 2020, so using bike and pedestrian routes would save about 13,000,000 km, which is a reduction of 2,720 tons CO_2 equivalent compared to the BAU.

Activity T7: Parking Policy Development

Parking policies are key to reducing emissions. Paid parking increases car maintenance expenses and parking limits make the use of private cars less attractive. Many cities use parking policies to reduce congestion in central areas and to improve traffic safety at the same time. Planning for parking measures requires the development of relevant legislation--then to establish municipal parking companies; to collect parking fees and use them to finance public transport; to purchase/install parking meters; and to ensure that urban planning committees designate parking areas.

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[14]Technologies for Climate Cahnge Mitigation – Tranport Sector, UNEP Risoe Center, 2011. http://tech-action.org/

It is difficult to estimate parking policy efficiency without including other measures. However, according to the Mitigation Measures Manual for Transport Sector,[9] a 10% increase in the cost of cars leads to a 3% car ownership decrease. It has been conservatively assumed that parking policies decrease car ownership by 1%, saving about 1594 tons of CO_2-equivelent emissions per year.

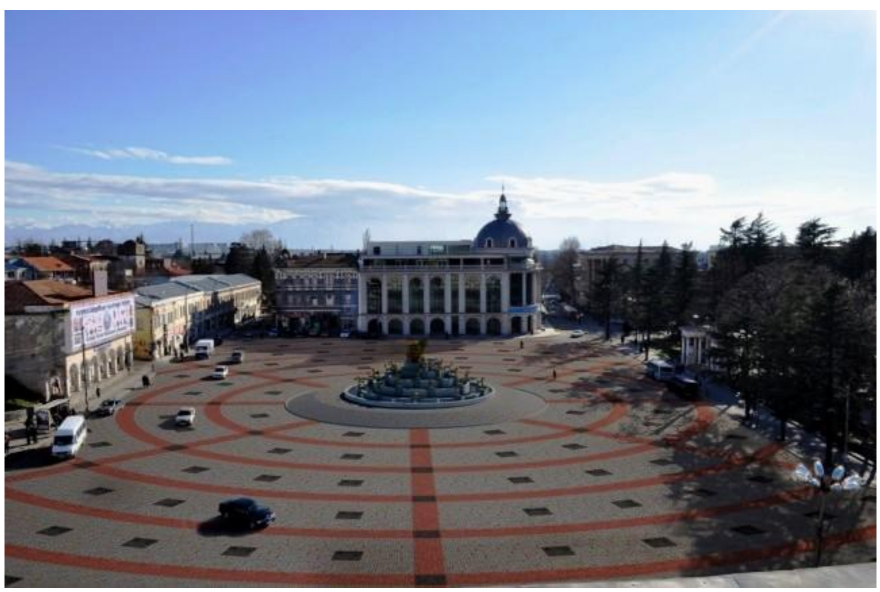
Activity T8: Technical Inspection and the Developing Fuel Quality Standards

The technical inspection of vehicles will likely become mandatory in Georgia after 2015, although details have not been determined. The Kutaisi City Hall will collaborate with national structures to develop European vehicle and fuel standards. Eventually, fuel consumption --thus greenhouse gas emissions and local pollutants --will be reduced, helping to improve living conditions and health in urban areas. Technical inspection will promote better maintenance and technical equipment for cars. According to the Mitigation Measures Manual for the Transport Sector[9] a well maintained car's fuel consumption can be reduced by up to 3-7%, which implies important emissions reduction. Since most vehicles in Georgia are not new, they are less effective from an energy point of view. Emissions of private cars can be reduced up to 7%, which would lead to an 18,345 ton CO_2 equivalent emissions reduction.

Buildings

Sector overview

The development plan of Kutaisi is focused on attracting foreign investments, developing the industrial, commercial and tourism sectors, ensuring dynamic economic growth, creating new jobs, increasing the income of the population, while gradually overcoming poverty and promoting social improvement activities.



Pic. 2. Kutaisi central square

In such a dynamic environment, the construction and building sectors of Kutaisi is one of the most important for emissions reduction and sustaianble energy development. This includes private as well as municipal and other commercial buildings (offices, shops, hotels etc). A significant prerequisite for reducing greenhouse gas emissions is to lessen energy consumption in buildings, therefore measures to increase energy efficiency and renewable energy need special attention and planning.

According to the Housing and Communal Service Department of Kutaisi City Hall, there are 19,214 buildings in Kutaisi with a total area of 3,375,672 m^2. A detailed breakdown of building types is shown in Table 17.

Table 17. Municipal and Residential Buildings Inventory in Kutaisi

Building Type	Quantity	Total Area m2
Residential Buildings		
1-2 Storeys	271	320,322
3 – 5	337	797,287
6 – 9	300	1,308,152
10 – 16	22	60,455
1 – 2 Storey Private	18,284	889, 456
Municipal Buildings		
Kindergartens	35	47,707
Non municipal, Commercial and Governmental Buildings		
Public Schools	38	187,555
Medical Centers	28	81,626

Residential buildings are generally one- or two-storey houses in relatively good condition, as their most are private property. Multi-storey housing is also privately owned (each apartment), but most need capital repair especially for areas with common ownership such as roofs, entrances, stairs, elevators, utility facilities etc., which are in extremely poor condition. Nineteen tall buildings in the city and 14 apartment buildings on the right bank of the Rioni River need urgent rehabilitation.

The Municipal Government is implementing measures to improve the conditions of buildings. Some of the measures (roof repair, entrance rehabilitation, etc) will contribute to energy efficiency. Some carried out before 2014 and planned for 2014 include:

- Condominium communities will be provided with 442,448 m^2 of roofing materials within the framework of programme “Korpusi” in 2014, with an additional 87,376 m^2 roofing (waterproofing material)- 51,948 m^2; galvanized corrugated roofing - 35,428 m^2 ; galvanized corrugated sheets – 1 191 m^2 ; for a total amount of 700,000 GEL.

- 477 elevators out of 943 have been refurbished (3 new elevators installed in newly constructed houses), the technical condition of 310 has been maintained by the residents themselves, 156 elevators still need repairs. The rehabilitation of 44 elevators is planned through co-financing and 467,656 GEL is allocated for this purpose.
- The total number of entrances to residential buildings is 2,358, with 79 rehabilitated within the "Korpusi" program. The renovation of 76 entrances is planned through condominium co-financing in 2014 at a cost of 440,000 GEL.
- Water and sewer rehabilitation works have been carried out through co-financing in 106 buildings out of 930. Water and sewage pipe rehabilitation is scheduled for 19 apartment houses in 2014 for a total of 84,525 GEL.
- Broken connections of panels in 10 panel-type residential buildings have been filled by insulation materials. The upper parts (parapets) of 98 buildings have been fundamentally repaired.
- 772 internal waste collection spaces and containers have been demounted in 328 apartment buildings, with disinfection and pest eradication. These have been replaced by 532 mobile waste containers, with a total of 1.10 m^2 galvanized steel
- A pilot program with total budget of 150,000 GEL has been developed to cover the costs of residential houses with unsafe roofs, with full funding from the local government in 2014. This program targets families whose financial income is less than 57,000 (poverty rating score). Project and cost estimation documents will be prepared for 41 private residential houses according to applications from private persons and municipal bodies.

In spite of these measures, the residential and municipal buildings sector of Kutaisi are high consumers of energy. Most buildings were constructed during the Soviet period, and according to poor standards and do not meet energy saving requirements. They often have open entrances, thin walls, and poor wooden windowframes with a single glazed pane. They have a very low thermal resistance coefficient and poor exterior thermal resistance. These are only a few of the issues that lead to high building energy losses and therefore high potential for savings.

Total Energy Consumption in Kutaisi

Electricity

According to the official statistics the city consumed

In 2012: 280, 235, 997 kWh of electricity, including:

- Household sector – 99,439,581 kWh/y;
- Non-residential sector – 180,796,416 kWh/y.

In 2013: 254,272808.18 kW/h of electricity, including:

- Household sector – 98,064,267. 63 kWh/y;
- Non-residential sector – 156,208,540. 55 kWh/y.

Natural Gas

In 2012: 38,902,599 m3 of natural gas was consumed, including:

- Industry -11,748,105 m3
- Population - 27,154, 494 m3

In 2013: 38,443,386 m3 of natural gas was consumed, including:

- Industry -10,669,161 m3
- Population - 27,774,225 m3

Firewood Consumed: According to expert estimates, firewood consumption in private houses is 30,000–40,000 m3. In 2012: 3,305 m3; In 2013: 2, 765 m3;

Municipal building annual energy consumption according to type of energy sources:

Electricity

Total electricity consumption of Municipal buildings for **2012** was 13,202 298 kWh. Total electricity consumption of Municipal buildings for **2013** was 14,086 581 kWh.

Natural Gas

Total amount of natural gas consumed by municipal buildings in 2012 was 561,137 m3; Total amount of natural gas consumed by municipal buildings in 2013 was 477, 526 m3;

Liquid Gas

The Nursery Union N(N)LE of municipal buildings used liquid gas amounting to 460 kg in 2012. Municipal buildings consumed 554 kg liquid gas in 2013, including: N(N)LE Nursery Union N(N)LE - 494 kg liquid gas; Thanksgiving House of Kutaisi N(N)LE – 60 kg liquid gas.

Firewood

The total amount of firewood used by municipal buildings in 2012 was 385.5 m^3 and in 2013 it was 770 m^3.

Energy resources consumed by different buildings under Kutaisi Municipality for the years of 2012 – 2013 are given below (Table 18).

Table 18. Annual Energy Consumption

#	Entity	Electricity kWh/y		Natural Gas m^3/y		Liquid Gas kg/y		Firewood m^3/y	
		2012	2013	2012	2013	2012	2013	2012	2013
1	N(N)LE Nursery	533,941	690,136	256,925	275,295	460	494	-	-

	Union								
2	N(N)LE Sporting Institutions Union	235,666	228,981	38,813	41,596	-	-	-	-
3	Cultural, Art and Educational Institutions Union	112,404	109,833	20,498	23,588	-	-	3	
4	Ice Skating Rink	436,200	347,400	17,232	4376	-	-	-	-
5	Scientific Library	74,914	74,622	-	-	-	-	-	-
6	The Folklore Center, State Dance and Song Ensemble	17,680	14,871	1983	7303	-	-	-	-
7	Students' and Youth Park	21,073	15,000	-	-	-	-	-	-
8	Botanical Garden	-	2263	-	-	-	-	-	-
9	Thanksgiving House	42,052	6419	3522	6223	-	60	-	-
10	Lado Meskhishvili State Drama Theatre	25,091	19,667	-	30,845	-	-	-	-
11	Opera and Ballet Theatre	68,418	73,785	33,014	37,108	-	-	-	-
12	Puppet Theatre	24,611	19,324	-	-	-	-	-	-
13	Encyclopedia LTD	1927	2000	-	-	-	-	-	-
14	Kutaisi Disinfection Station	600	550	-	-	-	-	-	-
15	Georgian Traditions LTD	18,412	7500	-	-	-	-	-	-
16	"Kutservicegroup" LTD	18,719	18,549	-	-	-	-	-	-
17	Kutaisi Elevator LTD	1200	1110	-	-	-	-	2.5	2

18	Uckimerioni LTD	182	90	-	-	-	-	-	-
19	Gumati Medical Policlinic LTD	1037	3275	-	-	-	-	-	-
20	Kutaisi Mixed Policlinic #4 LTD	49,166	45,040	-	-	-	-	-	-
21	Green Kutaisi LTD	4600	2787	-	-	-	-	-	-
22	City Hall Administration Building and City Territorial Bodies	11,514 405	12,346 376	189,150	51,192	-	-	380	768
	Sum	**13,202 298**	**14,086 581**	**561 137**	**477 526**	**460**	**554**	**385.5**	**770**

Methodology

Methodology for 2012's CO_2 baseline emissions inventory and future trends (up to 2020) in the building sector is the same as described in the transport sector. CO2 emission factors and transfer coefficients as well as methane and nitrous oxide emission factors resulting from incomplete combustion of fuel have been taken from IPCC 1996, and are shown below (Table 19).

Table 19. Methane and Nitrous Oxide Emission Factors for Buildings (kg/MW/h)

Greenhouse Gas	Natural Gas	Oil Products	Firewood
CH_4	0.018	0.036	1.08
N_2O	0.00036	0.002	0.014

The emissions reduction potential after energy saving measures has been assessed through selecting buildings typical for Kutaisi, carrying out energy audits and evaluating energy efficiency measures, then extending these results to other buildings. Methodology in more detail is described below.

Buildings such as residential houses, schools, hospitals, kindergartens, hotels, educational institutions, shops, offices etc. have significant potential for energy conservation. The determination of their actual potential for energy conservation requires optimal methods and means to conduct an energy audit. This includes building studies, situation assessment and evaluation as well as other measures to reduce energy consumption and improve the buildings' microclimates. Results are reflected in the energy audit report that describes recommended measures with appropriate investments, savings and profits. Energy audits must be made by trained and experienced energy auditors.

It is impossible to assess the energy-saving potential in a building by only simple accounting or fixing annual energy consumption (e.g. 700 000 kWh/y). This figure does not show whether the building is big or small and other factors. A clear picture on energy efficiency of buildings is given by specific energy consumption i.e. energy used per square meter, e.g. 130 /m^2 annually. However, there are many other factors such as building type (administrative, hospital, school etc.), climate conditions, building insulation levels, etc. that influence energy consumption rates. Therefore the specific energy consumption of buildings should be compared with "standard" key numbers of the country as a whole.

Key numbers should reflect model values of specific energy consumption taking into account all mentioned factors. Comparing measured and calculated values with key numbers permits a rapid evaluation of energy efficiency and energy-saving potential of buildings. Specific energy consumption rates are also indicators of energy efficiency for the building just as fuel consumption per mile defines the energy efficiency of a car.

Significant reductions of energy expenses in buildings are possible by realizing various measures. Some of these include energy consumption management, improving winterization techniques, the automatic regulation of administration, automatic hydraulic balancing of heating systems, installation of thermostatic valves on radiators, additional insulation of constructions and other measures. These significantly improve the deteriorated ecological situation both locally as well as on the global scale.

In order to assess buildings' energy saving potential, an energy audit is required, which addresses all the factors influencing energy consumption: building insulation (walls, windows, roofs, floors), heating system, ventilation system, hot water supply system, automated management system, lighting, miscellaneous equipment and air-conditioning system. The overall process of an energy audit is divided into six important steps: project identification, scanning, energy audit, business plan, implementation (realization) and exploitation.

In order to develop a single document on energy consumption of a building, energy and power consumption budget standards are developed and include eight sectors: heating, ventilation, hot water supply, fans/pumps, lighting, miscellaneous equipment, cooling and outdoor equipment.

Budget division into these eight sectors facilitates annual energy and power consumption modification analysis. Both annual energy consumption (kWh/y) and specific annual energy consumption values (energy consumption for 1 m^2 space heating. kWh/m^2y) must be considered.

The budget for residential and household buildings can be simplified to three sectors: heating (including natural ventilation); hot water supply; and household (lighting, equipment--including farm equipment).

An energy audit of typical buildings in Kutaisi has been conducted via "Key Numbers" of the ENSI software. A Norwegian Consulting Company—ENSI-- founded in 1992, developed simple software called "Key Number" for a quick calculation of energy characteristics that can be applied both for projecting rates for new buildings and reconstruction activities and for assessing energy-saving measures for existing buildings. Key figures reflect model values of specific types of energy consumption, taking into account all factors. Comparing measured and calculated values of energy consumption with key numbers permits a rapid assessment of energy efficiency and energy saving potential.

ENSI software provides a database for each energy budget article and reflects data obtained after carrying out energy-saving measures. For example, the ENSI software energy budget article "Heating" includes a first column with the most important "parameters" affecting energy consumption required for heating. The second column shows "model values" of each parameter based partly on construction standards, rules and regulations and partly on experience gained from various projects (Fig. 13. ENSI Software format for Energy

Budget Sector "Heating"). The third column, "condition", includes the real technical conditions of a given building selected for an energy audit, and its "measured energy consumption" required for heating (kWh/m^2 y).

Today the actual exploitation conditions of buildings in Georgia differ substantially from project/normative conditions. Thus, measured energy consumption may be higher than the one calculated e.g. due to water leakage or improper operation of a heating system; or lower, e.g. due to heating or ventilation system shutoffs. Additionally, along with energy-saving measures, an owner might need to improve the microclimate in the building by installing a forced air ventilation system or improving the existing system. All these will lead to an increase in energy consumption.

Due to the fact that in most cases "measured energy consumption" does not coincide with "estimated energy consumption", calculated values of energy consumption provided in the fourth column of ENSI software have to be used as a "basic line", to get accurate values of energy savings. "ENCON measure" contains alternative energy saving solutions and energy-saving measures and "after ENCON" column (saving by each parameter/measure) lists the savings.

Parameter	Reference	Condition	Baseline	Sensitivity	kWh/m²y	ENCON measure	After ENCON
1. Heating	**46,4**	kWh/m²y					
U - wall	0,30 W/m²K	0,45	0,45	+ 0,1 W/m²K	= 6,78	0,30	-9,51
U - window	2,40 W/m²K	3,00	3,00	+ 0,1 W/m²K	= 1,56	1,30	-24,77
U - roof	0,20 W/m²K	0,20	0,20	+ 0,1 W/m²K	= 1,71	0,20	
U - floor	0,30 W/m²K	0,30	0,30	+ 0,1 W/m²K	= 1,71	0,30	
Form - factor	0,31 -	0,31	0,31			0,31	
Window area	15,1 %	15,1	15,1			15,1	
Total solar gain	0,55 -	0,55	0,55			0,55	
Infiltration	0,25 1/h	0,40	0,40	+ 0,1 1/ h	= 11,23	0,25	-15,76
Indoor temperature	21,0 °C	21,0	21,0	+ 1 °C	= 5,92	21,0	
Setback temperature	18,0 °C	18,0	18,0	+ 1 °C	= 4,49	17,5	-2,11
Contribution from							
Ventilation	kWh/m²y	-2,01	-2,01			-1,41	
Lighting	kWh/m²y	21,32	21,32			19,98	
Various equipment	kWh/m²y	12,71	12,71			11,91	
Sum 1 kWh/m²y		73,5	73,5			24,6	
Distribution losses	2,0 %	2,0	2,0			2,0	
Automatic control	98,0 %	Modern	Modern	Poor +3 %, Manual +5 %		Modern	
Sum 2 kWh/m²y		76,5	76,5			25,6	
O & M / EM	98,0 %	95,0	95,0			98,0	-2,32
Sum 3 kWh/m²y		80,6	80,6			26,1	
Energy supply efficiency	100,0 %	100,0	100,0			100,0	
1. Heating corrected	kWh/m²y	80,6	80,6			26,1	

Fig. 13. ENSI Software format for Energy Budget Sector "Heating"

A similar structure is used for other sectors as well (ventilation, hot water supply, fans and pumps, lighting, other equipment, cooling and outdoor equipment). Results are collected in the "energy budget" table (Fig. 14).

Energy Budget | Power Budget | ENCON Measures | ET curve | Annual consumption

Project		
test714	Reference building	Office
	Reference condition	1987
	Climatic zone	Oslo
	Heating season	15.9 - 15.5

Budget item	Reference	Condition		Baseline before ENCON		After ENCON	
	kWh/m²	kWh/m²	kWh/y	kWh/m²	kWh/y	kWh/m²	kWh/y
1. Heating	46,4	80,6	191 755,4	80,6	191 755	26,1	62 149
2. Ventilation	33,5	44,2	105 148,1	44,2	105 148	42,0	99 901
3. DHW	9,9	19,8	47 012,5	19,8	47 013	10,4	24 784
4. Fans and pumps	20,2	23,0	54 676,0	23,0	54 676	17,3	41 071
5. Lighting	31,5	31,5	75 072,0	31,5	75 072	31,5	75 072
6. Various	24,0	24,0	57 066,4	24,0	57 066	24,0	57 066
7. Cooling	0,0	0,0	0,0	0,0	0	0,0	0
Total	165,5	223,0	530 730,6	223,0	530 731	151,3	360 043
8. Outdoor			0		0		0

Fig. 14. Energy Budget

Carbon Dioxide Emissions Assessment

In order to assess emissions reduction potential, an energy audit of typical buildings was conducted and data applied to other buildings. To determine whether applying this data to other buildings, the energy consumption was compared with three scenarios. The first was based on the annual energy data, second on data about buildings and the third on population data.

According to the first scenario, it is possible to estimate an annual energy consumption on the basis of annual statistical data of consumed natural gas, electricity and firewood (E1, kW*h/y). The second scenario needs a detailed energy audit of different type of pre-selected “typical” buildings and an estimation of specific energy expenditures (energy consumption per m^2, kW*h/m^{2}y) on heating, cooking and electricity use. An energy audit carried out with appropriate methods and the software format would allow us to determine the actual potential of energy-savings, involves a situational analysis and other measures to reduce energy consumption and CO2 emissions. Following this, specific energy consumption, the estimation of annually consumed energy on heating, hot water, cooking and electricity becomes possible (E2, kW*h/y) for various types of buildings. The third scenario is based on statistical data on the number of people living in the area. Determination of per capita energy consumption (kWh/y per capita) allows us to calculate the approximate annual energy consumption of the entire population (E3, kW*h/y) in the area. Finally, cross comparison of these three scenarios makes it possible to determine the accuracy of calculation for each scenario under the condition that (E1 = E2 = E3).

Base Year (2012) Intervention and Greenhouse Gas Emissions Baseline Scenario (2013 – 2020)

The structure of the building sector in Kutaisi includes three sub-sectors according to the sustainable energy development manual: municipal buildings, residential buildings and "other" (including commercial buildings). The following data are based on the energy consumed in the buildings in 2012 and given below (Table 20).

Table 20. Final Energy Consumption in Buildings' Sector (MWh) - 2012

Subsector	Electricity	Natural Gas	Liquid Gas	Firewood	Total
Municipal Buildings	13,203.35	5236.14	6.05	803.19	19,248.73
Other (Commercial) Buildings	6370.51	202.41	0	0	6572.92
Residential Buildings	99,447.54	253 386.78	0	83 340.00	436,174.32
Sum	**119,21.40**	**258 825.34**	**6.05**	**84,43.19**	**461,995.98**

GHG emissions in CO_2 equivalent from buildings in 2012 amounted to 70.6 thousand tons.

Table 21. Greenhouse Gas Emissions in CO_2 (tons) Equivalent from Buildings Sector - 2012

Subsector	Electricity	Natural Gas	Liquid Gas	Firewood	Total
Municipal Buildings	1795.66	1 054.68	1.38	21.8	2873.51
Other (Commercial) Buildings	866.39	40.77	0	0	907.16
Residential Buildings	13,524.86	51,038.10	0	2 262.00	66,824.96
Sum	**16,86.91**	**52,133.55**	**1.38**	**2 283.80**	**70,605.64**

The parameters of the building sector's energy demand and consumption are driven by the increase in fuel consumption in various sectors projected by the MARKAL-Georgia national model. This, in turn, is based on population growth, GDP growth and GDP per capita growth of the city. Methodological details are described in the "Transport" chapter.

According to the baseline scenario, energy consumption by household and municipal buildings will increase by 84%, exceeding 850.2 thousand MWh. GHG emissions are expected to increase by 106%.

Table 22. Final Energy Consumption in Kutaisi Buildings (MWh) - 2020

Subsector	Electricity	Natural Gas	Liquid Gas	Firewood	Total
Municipal Buildings	15,347.77	9121.38	0	387.4	24,856.54
Commercial Buildings	7 405.17	352.61	0	0	7 757.78
Residential Buildings	125,094.49	601,727.44	0	90,808.93	817, 630.86
Total	**147,847.43**	**611,201.43**	**0**	**91,196.33**	**850,245.18**

Table 23. Greenhouse Gas Emissions CO_2 eq. for Kutaisi Building Sector – 2020

Subsector	Electricity	Natural Gas	Liquid Gas	Firewood	Total
Municipal Buildings	2,087.30	1,837.26	0	10.51	3,935.07
Commercial Buildings	1007.10	71.02	0	0	1078.13
Residential Buildings	17,012.85	121 202.16	0	2 464.72	140 ,679.73
Total	**20,107.25**	**123,110.44**	**0**	**2475.24**	**145,692.93**

Action Plan for Reducing Emissions from Kutaisi Building Sector

A short-term strategy for reducing greenhouse gas emission from municipal and residential buildings of Kutaisi aims at reducing energy resources consumption by such measures as using energy efficient bulbs, improving heat insulation of roofing, entrance and other spaces of common use, repairing roof leaks and damage, repairing or replaceing windows and doors. All measures save significant amounts of thermal energy and are relatively affordable. These measures must be accompanied by information campaigns and appropriate training to raise public awareness.

A promising way of reducing carbon dioxide emissions is the use of renewable energy sources. Most energy resources are used for heating and hot water thus bio-waste and solar energy could significantly reduce the amounts of natural gas and CO2 emissions in the heating and hot water supply systems of buildings.

Implementing these measures--even in 16% of private homes--will reduce carbon dioxide emissions by 20% overall in the city. Therefore, a long-term strategy of GHG emissions in Kutaisi may mean the production of waste biomass blocks as well as the installation of solar collectors to use in local heating systems in municipal and residential buildings. These measures would not only serve the purpose of water heating but promote more non-conventional renewable energy sources.

The following measures can be carried out in Kutaisi within the short- and long-term strategy:

- Use of Bio-waste pellets in municipal and private buildings (pilot projects);
- Lighting systems with energy-saving bulbs;
- Thermal insulation of roofs in kindergartens;
- Solar collectors in kindergartens;
- Energy-saving lights in shared residential spaces;
- Heating shared residential areas and entrances;
- Thermal insulation of roofs in private houses;
- A pilot project to equip housing for refugees with energy-saving technology;
- Installing solar collectors for water heating in private buildings;
- House roofing and thermal insulation program for 41 families registered with the social services.

A detailed energy audit was conducted in the building sector of Kutaisi on April 10-12, 2014 to determine emission reduction potential for this strategy. Nine buildings were selected according to their energy consumption.

Pic. 3. Kutaisi Public School #40 (address: #22 Nikea II turn)

Pic. 4. Kutaisi Kindergarten #27 (address: #14 Nikea II turn);

Pic. 5. Leri Khonelidze Clinic Ltd (address #11 Lortkipanidze St.)

Pic. 6. Two-storey Residential Building (address: #24 Marjanishvili St.)

Pic. 7. Three-storey apartment building (address: #6 Zviad Gamsakhurdia I turn)

Pic. 8. Five-storey apartment building (address: #24 Ilia Chavchavadze ave);

Pic. 9. Eight-storey apartment building (address: #38 Zviad Gamsakhurdia ave.);

Pic. 10. Nine-storey apartment building (address: #12 Melikishvili St.);

Pic. 11. Single-family house (address: #6 Freedom St IV turn)

Actual energy-saving and emission reduction potential from these buildings have been determined by indepth research (see and Table 25).

Energy Expenses	Energy		Emission			
	Basic	Saving	Norm	Existing	Saving	Saving
	kW*h/ y	kW*h/ y	kg/ kW*h	T/y	T/y	%
1-2 Storey Buildings						
1. On heating	24,344 472.00	6,566,601.00	0.20	4917.58	1326.45	26.97
2. On hot water						
By natural gas	7,340,713.00	3,670,356.00	0.20	1482.82	741.41	50.00
By electricity	10,276,998.00	5,138,499.00	0.14	1397.67	698.84	50.00
3. On Electrical equipment, lights	13,197,266.00	2,504,918.00	0.14	1794.83	340.67	18.98
Sum	**55 159 448.00**	**17 880 374.00**		**9 592.91**	**3 107.37**	**32.39**
3-5 Storey Buildings						
1. On heating	54,215,516.00	15,945,740.00	0.20	10,951.53	3221.04	29.41
2. On hot watOner						
By natural gas	9,966,088.00	1,993 218.00	0.20	2013.15	402.63	20.00
By electricity	13,952 523.00	2, 790 505.00	0.14	1897.54	379.51	20.00
3. On Electrical equipment, lights	27,905,045.00	3,986,435.00	0.14	3795.09	542.16	14.29
Total	**106 039 171.00**	**24 715 897.00**		**18 657.31**	**4 545.33**	**24.36**
6-9 Storey Buildings						
1. On heating	75 273 385.00	19,160,498.00	0.20	15,205.22	3870.42	25.45

2. On hot water						
By natural gas	13,115,817.08	2,281,012.00	0.20	2649.40	460.76	17.39
By electricity	18,362,143.92	3,193,416.00	0.14	2497.25	434.30	17.39
3. On Electrical equipment, lights	32,846,568.00	5,707,091.00	0.14	4467.13	776.16	17.38
Total	**139,597,914.00**	**30,342,017.00**		**24 819.00**	**5 541.65**	**22.33**
<u>Private Houses</u>						
1. On heating	107,446,284.8		0.20	21 704.15		
By Natural gas		28,907,320	0.20		5 839.28	
By Biomass		37,606,200	2.20		7 596.5	
2. On hot water						
Natural Gas	5,781,464.00	5,781,464.00	0.20	1167.86	1 167.86	100.00
Electricity	8,094,049.60	8,094,050.00	0.14	1100.79	1 100.79	100.00
3. On Electrical equipment, lights	14,320,241.60	709,032.00	0.14	1947.55	504.43	
Total	**135,642,040**	**55,190,745**		**25 920.35**	**16 208.81**	**62.5**

Table 24. Existing Emissions from Residential Buildings and Possible Savings

Energy Expenses	**Energy**		**Emission**			
	Basic	**Saving**	**Norm**	**Existing**	**Saving**	**Saving**
	kW*h/ y	**kW*h/ y**	**kg/ kW*h**	**T/y**	**T/y**	**%**
<u>1-2 Storey Buildings</u>						

1. On heating	24,344 472.00	6,566,601.00	0.20	4917.58	1326.45	26.97
2. On hot water						
By natural gas	7,340,713.00	3,670,356.00	0.20	1482.82	741.41	50.00
By electricity	10,276,998.00	5,138,499.00	0.14	1397.67	698.84	50.00
3. On Electrical equipment, lights	13,197,266.00	2,504,918.00	0.14	1794.83	340.67	18.98
Sum	**55 159 448.00**	**17 880 374.00**		**9 592.91**	**3 107.37**	**32.39**
3-5 Storey Buildings						
1. On heating	54,215,516.00	15,945,740.00	0.20	10,951.53	3221.04	29.41
2. On hot watOner						
By natural gas	9,966,088.00	1,993 218.00	0.20	2013.15	402.63	20.00
By electricity	13,952 523.00	2, 790 505.00	0.14	1897.54	379.51	20.00
3. On Electrical equipment, lights	27,905,045.00	3,986,435.00	0.14	3795.09	542.16	14.29
Total	**106 039 171.00**	**24 715 897.00**		**18 657.31**	**4 545.33**	**24.36**
<u>6-9 Storey Buildings</u>						
1. On heating	75 273 385.00	19,160,498.00	0.20	15,205.22	3870.42	25.45
2. On hot water						
By natural gas	13,115,817.08	2,281,012.00	0.20	2649.40	460.76	17.39
By electricity	18,362,143.92	3,193,416.00	0.14	2497.25	434.30	17.39
3. On Electrical equipment, lights	32,846,568.00	5,707,091.00	0.14	4467.13	776.16	17.38
Total	**139,597,914.00**	**30,342,017.00**		**24 819.00**	**5 541.65**	**22.33**

Private Houses						
1. On heating	107,446,284.8		0.20	21 704.15		
By Natural gas		28,907,320	0.20		5 839.28	
By Biomass		37,606,200	2.20		7 596.5	
2. On hot water						
Natural Gas	5,781,464.00	5,781,464.00	0.20	1167.86	1 167.86	100.00
Electricity	8,094,049.60	8,094,050.00	0.14	1100.79	1 100.79	100.00
3. On Electrical equipment, lights	14,320,241.60	709,032.00	0.14	1947.55	504.43	
Total	**135,642,040**	**55,190,745**		**25 920.35**	**16 208.81**	**62.5**

Table 25. Emissions from Non-residential Buildings and Possible Savings

Energy Expenses	Energy		Emission			
	Basic	**Basic**	**Norm**	**Existing**	**Saving**	**Saving**
	kW*h/ y	**kW*h/ y**	**kg/ kW*h**	**T/y**	**T/y**	**%**
Kindergartens						
1. On heating	1,264,236.00	190,828.00	0.20	255.38	38.55	15.09
2. On hot water						
By natural gas	178,901.00	178,901.00	0.20	36.14	36.14	100.00
By electricity	250,462.00	250,462.00	0.14	34.06	34.06	100.00
3. On Electrical equipment, lights	310,096.00	78,717.00	0.14	42.17	10.71	25.38
Sum	**2 003 694.00**	**698 908.00**		**367.75**	**119.45**	**32.48**

Public Schools						
1. On heating	1,856,794.50	375,110.00	0.20	375.07	75.77	20.20
2. On Electrical Equipment	656,442.50	146,293.00	0.14	89.28	19.90	22.29
Total	**2,513,237.00**	**521,403.00**		**464.35**	**95.67**	**20.60**
Hospitals						
1. On heating	8,840,096	979,512	0.20	1785.70	197.86	11.08
2. On hot water						
By natural gas	795,854	795,854	0.20	160.76	160.76	100.00
By electricity	1,114,195	1,114,195.00	0.14	151.53	151.53	100.00
3. On Electrical equipment	4,595,544	1,428,455.00	0.14	624.99	194.27	31.08
Total	**15,345,688**	**4,318,015**		**2722.99**	**704.42**	**25.87**

Emission Reduction Action Plan for Buildings

Table 26. Action Plan to Reduce Emissions from Buildings

Sectors and Activities	Key Measures in Activities	Responsible Department, Person or a Company (If third party is involved)	Implementation Period (Start and End Date)	Expected Energy Saving from each Measure (MWh/y)	Expected CO2 (T/y) Reduction from each Measure	Cost of Measures (GEL)
Municipal Buildings						

(MB)						
Activity MB1	**Installation of space heating systems in municipal buildings**					
MB 1.1	Bio-waste pellet production and utilization in municipal buildings	Economic Policy Office in Kutaisi City Hall	2015-2017	126	25.45	15,000
Activity MB 2	**Installation of efficient lighting systems is municipal buildings**					
MB 2.1	Energy-saving lighting system	Economic Policy Office in Kutaisi City Hall	2015	161.73	22.05	14,000
Activity MB 3	**Renovation of municipal buildings**					
MB 3.1	Thermal insulation of roofs in kindergartens	Economic Policy Office in Kutaisi City Hall	2015-2018	57.42	11.5	35,000
Activity MB 4	**Utilization of renewable energy sources for hot water supply**					
MB 4.1	Installation of solar collectors in kindergartens	Economic Policy Office in Kutaisi City Hall	2015-2020	126	25.45	78,000
Activity MB 5	**Education/inform/ Public-awareness raising campaign**	Economic Policy Office in Kutaisi City Hall	2012-2020			
Activity MB 6	**Implementation of energy management and monitoring program in municipal buildings**		2012-2020			
MB 6.1	Control of energy policy adaptation,	Economic Policy Office in Kutaisi				

	encouraging behavior changes	City Hall				
MB 6.2	Municipal buildings" energy database development	Economic Policy Office in Kutaisi City Hall				
MB 6.3	Establish energy efficiency indicators to prepare documents necessary for state procurement of rehabilitation works	Economic Policy Office in Kutaisi City Hall				
Residential Buildings (RB)						
Activity RB 1	**Installation of efficient lighting systems**					
RB 1.1	Installation of energy-saving llights in common areas of residential buildings	Economic Policy Office in Kutaisi City Hall	2015-2017	223.5	30.4	22 800
Activity RB 2	**Renovation of residential buildings**					
RB 2.1	Heating in common areas of residential buildings – 76 entrances	Economic Policy Office in Kutaisi City Hall	2014	950	191.9	440,000
RB 2.2	Thermal insulation of roofs in private houses	Investor	2014-2020	35.7	7.2	11,800
RB 2.3	Reduced energy consumption house for refugees/pilot project/	Investor	2017-2018	150	30	120,000
Activity RB 3	**Utilization of renewable energy sources for hot**					

	water supply					
RB 3.1	Installation of solar collectors for water heating in private houses	Investor	2015-2020	184.2	37	65,000
RB 3.2	Roofing and thermal insulation program for 41 socially protected families	Economic Policy Office in Kutaisi City Hall	2014	240	48.5	150,000
RB 3.3	Bio-waste pellet production and use in residential buildings	Investor	2015-2020	147, 980	29,890	3,114, 000
Activity RB 4	**Public awareness raising/ information campaigns**					
RB 4.1	Training on energy efficiency issues in the buildings for various target groups	Economic Policy Office in Kutaisi City Hall				
RB 4.2	Mass media and energy efficiency information campaign	Economic Policy Office in Kutaisi City Hall				
Total				**150, 234**	**30,319**	**4,065, 600**

Detailed description of measures:

Measure MB1.1. Utilization of bio-waste pellets in municipal buildings (pilot project)

Bio-waste pellets can be used as fuel instead of natural gas in buildings. The bio-waste pellet is carbon-free fuel enabling a 20% emission reduction and scheduled for 2020. In order to determine all aspects of this measure a pilot project is desirable. The market price of one ton of organic waste pellets was 450 GEL due to the high cost of transporting sawdust used to make the pellets. Now, private companies selling sawdust will reduce their price to 250 GEL. Pellets heating capacity is 16,000 kJ/kg., which means that during 1 kg pellet combustion process 4.44 kWh energy is being released. The price for one kWh such energy is 250 / (1000 * 4.44) = 0.06 GEL/kWh. In comparison, the average price of 1000 m^3 of natural gas is 750 GEL for different consumer groups and state buildings. Its thermal capacity is 33 868 kJ/Nm^3.8.00 kWh of energy released during 1m^3 of natural gas combustion. Thus, the cost of 1 kWh energy produced by burning natural gas will be 0.09 GEL/ kWh.

The total amount of energy required for heating the pilot building (#27 kindergarten) will be about 126 MWh/y, for natural gas. However for burning biomass the additional expense would be 15,000 GEL for purchasing and installing a pyrolysis (induction) furnace. This type of furnace was produced by JSC Sarini in 2012 and installed in the Natakhtari village public school (Mtskheta region). In monetary terms, the annual savings will amount to 126 000 x 0.02 = 2520 (0.09-0.07=0.02 GEL/kWh) for heating with pellets. Additionally, bio-waste is carbon-free so conversion to this fuel reduces CO_2 emissions by 126 x 0.202[15]=25.45 tons per year. It is expected that the pilot project results will be extended to a minimum of ten more kindergartens. Profitability parameters of MB 1.1 measure are given below (Table 27).

Table 27. Profitability parameters of Measure MB1.1

Measure	Investment Cost GEL	Payback *PB	Internal Rate of Return (IRR) *IRR,%	Net Present Value Quotient *NPVQ	CO_2- Reduction T/Y
Central Heating System (F=2 798 ∂²)	15,000.00	6	16	0.61	25.45

**PB – Payback; *IRR – Internal Rate of Return; *NPVQ - Net Present Value Quotient*

Measure MB2.1. Lighting System with Energy-efficient Bulbs

In order to assess energy savings potential of this activity data of the same #27 kindergarten have been used. Energy savings potential has been determined via comparison of incandescent lighting with fluorescent. Lights are switched on in the building for about 20 hours a week.

Basic energy consumption for incandescent bulbs is 11,552 kWh according to ENSI software (see appendixes) and 6931 kWh for fluorescent ones, so energy saving for the pilot building will be 4621 kWh, or 4621 x0.16=739 GEL. Profitability parameters are presented inTable 28. Fluorescent lighting is going to be installed in at least 35 kindergartens.

Table 28. Profitability parameters of Measure MB2.1

Measure	Investment Cost GEL	Payback *PB	Internal Rate of Return (IRR) *IRR,%	Net Present Value Quotient *NPVQ	CO_2- Reduction T/Y
Fluorescent bulb lighting system (F=2 798 ∂²)	400	0.5	185	7.47	0.63
In 35 Municipal kindergartens	14,000	0.5	185	7.47	22.05

Measure MB3.1. – Thermal Insulation of Roofs in Kindergartens

It is known, that a building and its heating system is one unit. Thermal insulation of roofs reduces heating system's load. The following value has been calculated for the ceiling resistance coefficient: R=0.70 m^2deg/W, and with further insulation it would be R=1.0 m^2deg/W, for a ceiling area of 1400m^2.

Resulting energy savings under this measure is 11,484 kWh/y according to ENSI. Using natural gas woud save: 11,484/8.00 = 435 m^3 or 1435 x 0.75 = 1076 GEL. Investment cost of the measure is 7000 GEL; CO_2 reduction 11,484 x 0.202= 2.30 t/per year. Profitability parameters of the measure are given below (Table 29). The installation of thermal insulation for roofs is planned for at least five kindergartens with the same ceiling areas.

Table 29. Profitability parameters of Measure MB 3.1

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2- Reduction t/y
Thermal Insulation of Roofs (F=2 798 ∂²)	7000	6.5	14.4	0.48	2.3
5 Kindergartens	35,000	6.5	14.4	0.48	11.5

Measure MB 4.1. Solar Collector Utilization in Kindergartens

Solar collectors convert radiation into heat energy and then give the heat to water, which is provided to buildings. This measure aims to use solar collectors for hot water in Municipal Kindergartens. About 4000 liters of hot water (40 degrees) a day is consumed in #27 kindergarten (295 children and 45 employees) which needs 25,123 kWh energy per year. Solar energy absorption (insolation) in Kutaisi is approximately 1200 kWh per year. If solar collector surfaces are oriented at 90-degree angles they can increase insolation by 25%, which is 1500 kWh/m²/y. If solar energy collector efficiency is 70%, 1050 kWh/m² energy would be available.

If solar vacuum collectors are installed on roofs, they will obtain 25,200 kWh energy from 24 m² of surface area per year. Standard 2m² solar energy collectors cost 1300 GEL including installation. Twelve units are needed for each of 27 kindergartens at a total investment cost of 15,600 GEL. If the same amount of energy (25,200 kWh/y) is created with natural gas it would require 25,200 /8.00 =3150 m³, or 3150 x 0.75=2362 GEL. The reduction of CO_2 emissions if natural gas use is changed to solar energy will be 5.09 per year. The profitability parameters of this measure are given below (Table 30). Solar water heating is being considered for five kindergartens.

Table 30. Profitability parameters of Measure MB 4.1

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2- Reduction t/y
Hot water supply though solar energy (F=2 798 ∂²)	15, 600	6.6	14	0.45	5.09
5 Kindergartens	78,000	6.6	14	0.45	25.45

Measure RB1.1. Installation of Fluorescent Bulbs in Common Areas of Residential Buildings (76 Entrances)

This measure includes replacement of incandescent bulbs with fluorescent ones for buildings with common areas. For example, a common space of F=389 m^2 in a nine-storey building with stairs has a minimum energy consumption for incandescent lighting of 3.5 W/m^2. This corresponds to a total consumption of 1.36 kW. Assuming that incandescent bulbs work 55 hours a week, the annual consumption would be 1.36*55/7 *365= 3900 kWh. Their replacement with fluorescent bulbs will save 2941 kWh energy (2 941 x 0.16 = 471 GEL) as they consume 3-4 times less energy. The total number of replaced bulbs will be 45 lights for nine floors and five entrances which will cost about 360 Gel. CO_2 emission reduction from a building will be 0.40 t/y. Results of this example can be used for other buildings assuming that this change will make energy savings of 7.56 kWh/m^2 in common spaces per year. The profitability parameters of the measure are given below (Table 31). The plan is to replace incandescent bulbs with fluorescent ones in 76 entrances.

Table 31. Profitability parameters of Measure RB 1.1

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2– Reduction t/y
Lighting with fluorescent bulbs	360	0.8	129.7	4.98	0.4
In 76 entrances	22 800	0.8	129.7	4.98	30.4

Measure RB 2.1. – Heating Common Spaces and Entrances of 9-storey Residential Building

This measure aims to install metal-plastic windows on each floor's common space. Heating buildings and minimizing heat loss will save up to 950 MWh of energy. The corresponding natural gas savings would be about 950,000/8.00=118 750 m^3 and emissions reduction 191.90 t/y. This represents 118,750x0.45 = 53,437 GEL per year. Approximately 3826 m2 metal-plastic windows would be installed in 76 entrances under this measure, at a total investment of 115 USD/m2 or 826,440 000 GEL. Profitability parameters of the measure are presented below (Table 32).

Table 32. Profitability Parameters of Measure RB 2.1

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2– Reduction t/y
Heating common spaces of 9-storeys in 15 residential	440,000	8.3	12	0.36	191.9

buildings (76 typical entrances)					

Measure RB2.2 – Thermal Insulation of Roofs in 2-storey Private Houses

Additional thermal insulation of private house roofs i.e. raising of roofs' thermal resistance coefficient from R=0.70 m^2deg/W to R=1.00 m^2deg/W, will save up to 1788 kWh energy resulting in a CO_2 emissions reduction of 0.36 t/y or 1788 x 0.056 = 100 GEL per year. Investment and installation costs are 5 GEL per m2 and total investment will be 118 m 2 x 5.00 USD / m 2 = 590 GEL. Profitability parameters of the measure are given below (Table 33).

Table 33. Profitability Parameters of Measure RB 2.2

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2- Reduction t/y
Roof thermal insulation in 2-storey private houses	590	5.9	16.6	0.76	0.36
Roof insulation in 20 analogous houses	11 800	5.9	16.6	0.76	7.2

Measure RB 2.3 – Reduced Energy Consumption House for Refugees/pilot project

Expected energy savings after implementation of the measure is 150 MWh and CO_2 emissions reduction from residential buildings will be 30 t/y. According to City Hall, 17,000 refugees live in Kutaisi today and the development of compact housing is being considered for them. The measure foresees Improving the thermal insulation of at least one external wall of each building (3000 m^2), along with the installation of efficient lighting and of new heating equipment with a solar hot water supply system. The profitability parameters of the measure are given below (Table 34).

Table 34. Profitability Parameters of Measure RB 2.3

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2– Reduction t/y
Energy Efficient Building (3000 m^2 external walls)	120,,000	8.5	11.7	0.39	30

Measure RB 3.1. – Installation of Solar Collectors for Water Heating in Private Houses/Investor

The same measure concerning municipal buildings is described in paragraph MB 4.1. Its results can be applied to residential buildings as well. A pilot project will be launched with the participation of investors, to determine optimal technical solutions. The annual demand for hot water supply per private house is 3,685 kWh/y. In case of conversion from natural gas to solar energy CO_2 emissions reductions will be 0.74 tons per year. The scheme could involve 10,000 residential houses, which would allow significant savings through renewable energy. The profitability parameters of the measure are presented below (Table 35).

Table 35. Profitability Parameters of Measure RB 3.1

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2– Reduction t/y
Installation of solar collectors for hot water	1300	6.2	15	0.55	0.74
For 50 residential buildings	65,000	6.2	15	0.55	37

Measure RB 3.2. Roofing and Thermal Insulation Program for 41 Socially protected Families

The additional insulation of the roofs of residential buildings i.e. raising the roof thermal resistance coefficient from R=0.70 m^2deg/W to R=1.00 m^2deg/W, will save 1788 kWh energy, and reduce CO_2 emissions by 0.36 t/y. Roof insulation for residential buildings will save up to 240,000 kWh of energy. These savings will be followed by CO_2 emissions reductions of 48.50 t/y or 240,000 x 0.056= 13,440 GEL per year. Investment and installation costs are 5 GEL and total investment will be 6000 m^2x 25.00 Gel/ m^2 = 150, 000 GEL. Profitability parameters of the measure are presented below (Table 36).

Table 36. Profitability Parameters of Measure RB 3.2

Measure	Investment Cost (GEL)	Payback PB	Internal Rate of Return (IRR)	Net Present Value Quotient *NPVQ	CO_2- Reduction t/y
Roof insulation	150,000	11.2	8	0.01	48.5

This is not a social program and we do not consider low NPVQ when implementing.

Measure RB 3.3. – Bio-waste Pellet Heating in Private Houses/pilot project

The same measure for municipal buildings is described in Measure MB 4.1, and the results will be applied to residential buildings as well. It is necessary to launch a pilot project with the participation of investors to determine optimal technical solutions. The annual demand for heating per house is 28,513 kWh/y. CO_2 emissions reduction when there is a conversion from natural gas to biomass will be 28,513 x 0.202=5.76 t/y. This measure implies a 600 GEL investment to buy a pyrolysis (induction) stove. In monetary terms, annual savings will be 28,513 x 0.02 = 570 GEL. (0.09-0.07=0.02 GEL/kWh is the price difference between pellets and gas).

Pilot project results would propably involve 5190 residential buildings to increase renewable energy at total energy consumption rates. The profitability parameters of the measure are given below (Table 37).

Table 37. Profitability Parameters of RB 3.3 Measure

Measure	Investment Cost (GEL)	Payback PB	Net Present Value Quotient *NPVQ	CO_2- Reduction t/y
Per House	600	1.1	6.98	5.76
5 190 Houses	3 114 000	1.1	6.98	29 890

Street Lighting

Sector Overview

Kutaisi is one of the oldest cities in the world and it has remained the largest city in West Georgia. Today it is second largest according to its population and its political and economic importance.

Pic. 12. Historical area, International airport, and Palm alley in Kutaisi

Over recent years several significant developments took place in Kutaisi, such as construction and opening of the Kutaisi International Airport, the rehabilitation of a historical part of the city, and moving the Parliament of Georgia to Kutaisi. All these led to a significant increase of expenditures for street lighting. In 2012 even more electricity was consumed for fountains, traffic lights and illumination of public buildings.

Table 38. Energyconsumption and expenditure in street lighting sector in 2012

Infrastructure init	Electricity consumption (kWh)	Expenditure (GEL)
Traffic lights	86,620.00	13,859.89
Kutaisi street lighting*	9,412,671.32	1,506,102.97
Total	**9,499,291.32**	**1,519,962.86**

*The illumination of buildings, cultural monuments and similar objects are included in street lighting expenditures.

As shown in the table, electricity consumption in Kutaisi in 2012 was nearly 9.5 million kWh, which corresponds to an expenditure of over 1.5 million GEL per year. There are 13,635 lighting units which are described in Table 39 below.

Table 39. Bulb types and energy consumption

Bulb type	No. Units	Mean consumption /per unit	Total kW/h
Diode	42.00	0.015	0.63
Economy	1044.00	0.05	52.2
Halogen	142.00	0.37	52.6
Metal-halide	388.00	0.174	67.65

Sodium	11,971.00	0.175	2 091.43
Spiral	48.00	0.25	12.00
Total	**13,635.00**		**2276.51**

Methodology

The methodology described in the Transport Sector chapter was used for the inventory on CO_2 baseline emissions (2012) and future trends (until 2020). According to the MARKAL-Georgia baseline scenario, energy consumption by the street lighting sector will increase by 25% in 2020 (approximately 3740 new non-efficient sodium bulbs). The mean grid emission factor -0.136 t of CO2 /MWh in 2012 was taken as electric energy emission factor and it was assumed that it did not change during the period under discussion.

Baseline year inventory (2012) and greenhouse gas emissions baseline scenario (2013-2020)

In 2012 the electric power consumption by street lighting sector was 9412671 kWh and the emissions from this sector equaled correspondingly to 1280 t of CO_2 eq.

In the baseline scenario it was assumed that the increasing of number of lighting units in public areas would be conditioned by increasing lighting and widening of the city area. According to a standard assumption, additional lighting would be undertaken by using of cheap and non-efficient sodium bulbs. According to baseline scenario, street lighting energy consumption will increase in future and reach 11.8 thousand MWh by 2020, while CO_2 emission from this sector by that time will reach 1.604 thousand t per year.

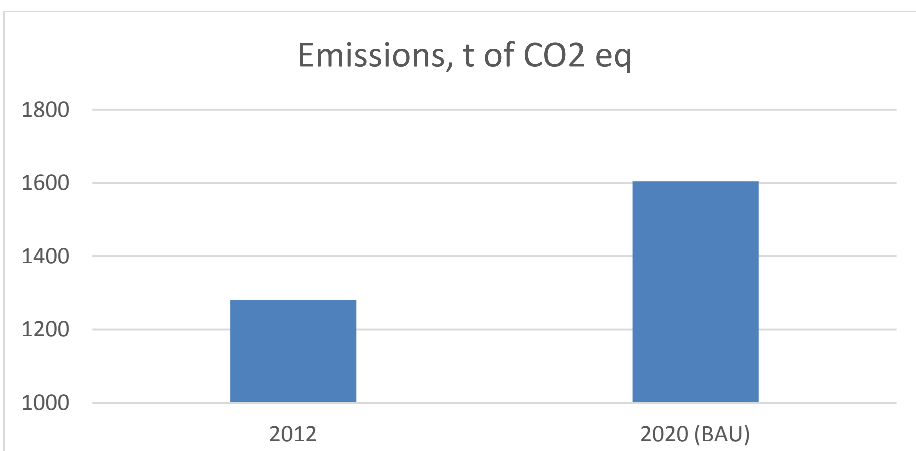


Fig. 15. Emissions from the street lighting sector in 2012 and 2020

Action Plan for reducing emissions from the Kutaisi street lighting sector

The Action Plan for the street lighting sector envisages following measures:

Activity PL1.

The modernization of the Kutaisi street lighting system implies following activities:

- Equipping the city street lighting system and parks with ECO-LAMPS to reduce expenses;
- Elaborating a Kutaisi Street Lighting Audit and Development Master Plan
- Establishing a centralized management system for street lighting
- Providing software to manage and monitor the street lighting system
- Eliminating energy losses in the street lighting system.

Among these activities, the replacement of non-efficient bulbs with ECO-LAMPS (fluorescent lamps) will have the most significant effect. ECO-LAMPS have many advantages, such as:

- High luminescence and a wide spectrum of colors;
- Water and dust resistance;
- Energy efficiency;
- Long life span.

The ECO-LAMP life time is minimum 20,000 hours, while halogen and luminescent lamps only have a 4000 hour lifetime. Though ECO-LAMPS demand a higher initial investment, together with electricity consumption expenditures costs are lower. According to these plans, 85% of bulbs should be replaced by ECO-LAMPS meaning that 14,700 new ECO-LAMPS must be installed. Thanks to these measures, about 6.7 thousand MWh of electricy will be saved and 911 t CO2 eq reduced. Purchasing and installing each lamp costs 270 GEL thus the total cost of this measure will be 4 million GEL. Replacement should be conducted gradually and-- if it is conducted over a period of eight years--the costs will be half a million per year.

The graph below shows GHG emissions according to the baseline scenario and according to the plan to install energy saving lights on light poles--the highest priority measure in the sustainable energy action plan for this sector.

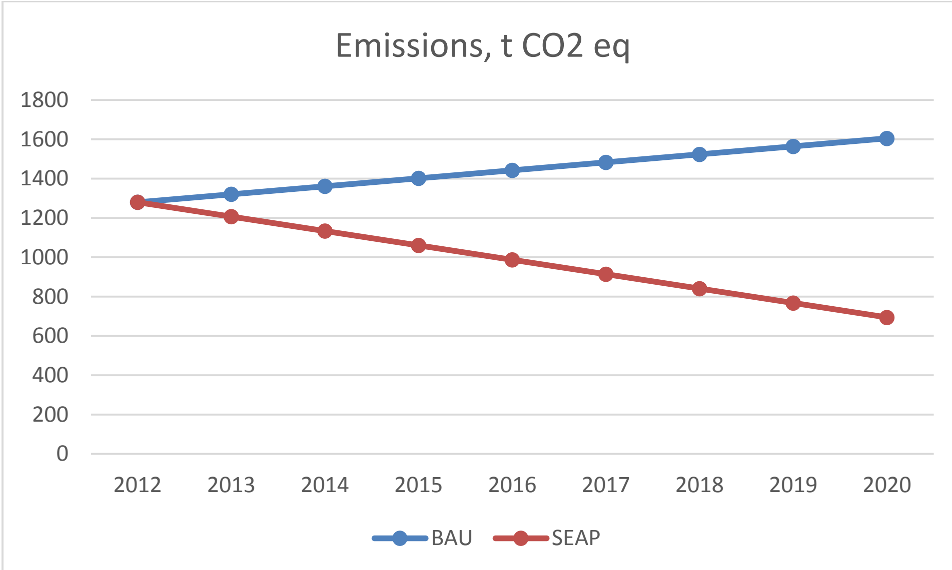


Fig. 16. Emissions from street lighting according to the BAU scenario and according to implementation of the measures envisaged by SEAP.

The following graph clearly indicates the benefits for the Kutaisi Municipality derived from implementation of the above mentioned measures:

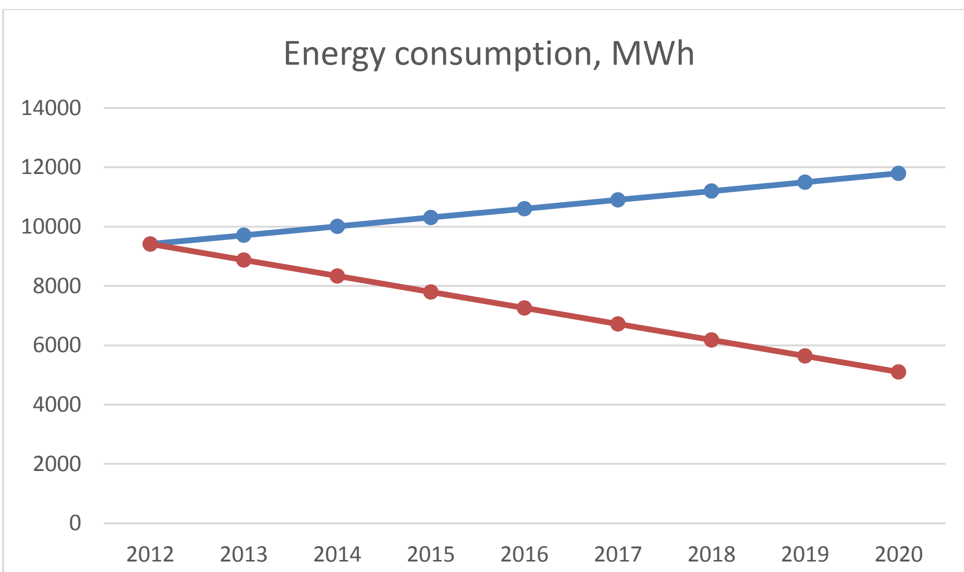


Fig. 17. Energy consumption for city street lighting according to the BAU scenario and according to measures envisaged by SEAP

Waste

Sector Overview

Solid waste

The infrastructure of Kutaisi developed intensively in recent years, with numerous new constructions, as well as cultural and recreational zones being developed. Consequently, energy demands are constantly increasing. The amount of waste produced within the city and its suburbs has greatly increased. One of the priorities for development of Kutaisi and the whole region for 2014-2016 is the improvement of waste management that implies closing old landfills and creating new ones with higher standards for municipal solid waste (MSW) and the reconstruction of the municipal water treatment facilities.[16]

To calculate emissions from the waste sector the guidelines for GHG inventories from the Intergovernmental Panel on Climate Change (IPCC), supported by the United Nations Framework Convention on Climate Change, have been used. According to these guidelines there are four categories:

- Solid waste disposal (6A)
- Wastewater treatment (6B1, 6B2)
- Waste incineration (6C)
- Other waste – municipal waters (6D)

The waste inventory in Kutaisi has been conducted only for two categories – solid waste disposal (6A) and municipal and commercial wastewater treatment (6B1). The two other IPCC categories have not been discussed because there is no waste incineration facility in Kutaisi, nor has an inventory for the disposal of other waste (industrial, medical and radioactive) been carried out. Approximately 50 000 m^3 of construction waste in Kutaisi is dumped in landfills every year together with the municipal waste. This was not taken into account when calculating general emissions from landfills, as construction materials practically do not contain organic or release methane. Sub-category 6B2 Industrial wastewater is also not discussed, because no official data on yearly production of industrial enterprises are available.[17]

Solid waste disposal

There is one waste disposal landfill in Kutaisi operational since 1956. It covers an area of 15 ha (150962.28 m^2) and is located close to the Kutaisi-Gudauta highway, along the Nikea Street and only ½ km from a populated area. The landfill borders the Rioni River to the east. To the north, within the limits of the landfill, an area of 50 000 m^2 is illegally planted with hazelnut trees, while in the rest of the northern part of the landfill an area of about 1 ha is naturally covered by small shrubs. The landfill is expanding toward the south. From the west it is limited by a concrete wall separating it from the Geguti highway[18] (Fig. 18).

[16] http://static.mrdi.gov.ge/52b312180cf2f9b6fab6b48d.pdf
[17] National Statistics Office of Georgia http://geostat.ge/
[18] http://geonews.ge/category/23/regions/news/193231/murgulia_qutaisis_nagavsayreli.html

Fig. 18. Kutaisi's active landfill

The Kutaisi landfill is one of the most problematic in Georgia. Several unsuccessful attempts have been undertaken to adjust its borders, but the local population still suffer from its proximity. Plastic bottles and bags cover the adjacent areas. The smell of decomposition smell covers local settlements and there are frequent cases of spontaneous methane flare-ups that are uncontrolled and threaten local residents.[19] Cases of spontaneous fires and smoldering combustion sites have been frequently reported.[20]

The Kutaisi landfill, which borders on the Rioni River, was not even fenced until 2004. Even now river waters wash out the waste when waters are high, and gradually part of the landfull has been washed into the river. From its initial area of 18 ha it has decreased to 15 ha.[21] Thus three hectares of waste have entered the Rioni River over the years and the problem continues. Leakage waters from the landfill also cause pollution to ground water on which the city relies for water supplies. Some of the residents draw there water independently from ground water sources for their household needs. However there is no monitoring of ground waters being conducted within the city.[22]

Waste is disposed of chaotically, and the whole area is almost fully covered, without planned sectors of disposal. The depth of the waste layer is 12-15 m in some places, although the landfill can be considered as

[19] http://regions.ge/Imereti&newsid=5874&year=2012&position=news_main

[20] http://geonews.ge/category/23/regions/news/193231/murgulia_qutaisis_nagavsayreli.html

[21] http://newpress.ge/index.php?page=4&staties_id=884&rub_param=8

[22] http://nala.ge/uploads/kutaisi.pdf

deep (>5). Even the circular road along the landfill perimeter is covered with waste. Inappropriate exploitation pollutes the irrigation channel that supplies water to five adjacent villages, so that the residents of these villages have to clean the channel at their own expense every year, and often it becomes necessary to clean it within the landfill territory.

Since September 2013 the responsibility for the Kutaisi landfill was transferred to the Ministry of Regional Development and Infrastructure of Georgia, where a Solid Waste Management Company was established.[23] According to the municipal department responsible for waste collection waste has increased 1.5 times.[24] At the Nikea landfill, which also serves Tskaltubo and Bagdadi, the amount of waste has totalled 7.5 million m^3, or in mass units – 1.5 million tons (1 m^3– 0.2 t[25]). In the future, increased amounts of solid municipal waste are expected because presently only 60% of waste, including that disposed by commercial users, arrives at this landfill. There are many illegal landfills in the suburbs, where construction and municipal waste is disposed together. All this illustrates the importance of introducing modern waste management and utilization systems in Kutaisi to address both waste management at generation sites (e.g. sorting waste by by the population, recycling, treatment on site), as well as at landfills. This would significantly reduce the amounts of waste at landfills, improve the management process at landfills, and promote an effective use of energy obtained from the waste.

The Solid Waste Management Company responsible for the Kutaisi landfill planned activities beginning in 2013. Some of these included the transfer of waste disposed at landfills to preliminary designated sites, pack it down and cover it by an insulating soil layer. They planned to collect and transfer all waste scattered around the landfill and install check-points for entering the area and to arrange storm-water inlet systems as well as fencing around the landfill. The plan also included installation of scales for weighing garbage and sanitary points, as well as a fire shield.[26] Kalasi Ltd, a sub-contracting company of the Solid Waste Management Company, is carrying the plan, and at present is flattening the area. The irrigation channel inside the landfill has been cleaned andwasteis being dumped only in one designated area. After the initial work of equalizing the surface, the landfill area will be divided into square zones for controlled dumping . These will be packed and covered by insulating soil covers. The whole landfill will be fenced.[27] A security point , garage for machinery and the weigh-station have been installed. Internal roads have been constructed and the divisions are being created. A protective dam for the river bank is being built and a coastal protection dam is being constructed on the Rioni River side to avoid waste washing into the water.[28]

According to the project of the Solid Waste Management Company of Georgia, the 'Kutaisi Integrated Solid Waste Management', after the containment of the old Kutaisi landfill, a new sanitary landfill[29] will open. Construction begins in 2014 and by 2016[30] it will serve not only Imereti, but also the Racha-Lechkhumi region (Fig. 19). According to this project, the new Imereti landfill will be created near the entrance to

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[23]The aim of the company is to reduce the impact of waste disposal and waste treatment; to avoid or minimize waste generation; to reduce hazardous waste and to close all landfills which do not comply with EU Directives; to provide safe and effective disposal and to create relevant infrastructures for waste separation and treatment http://www.mrdi.gov.ge/ge/structure#

[24]http://nala.ge/uploads/kutaisi.pdf

[25] Sanitary cleaning in settlements, 1990, p. 6

[26]http://waste.gov.ge/index.php?a=main&pid=103&lang=geo

[27]http://www.newpress.ge/index.php?page=4&staties_id=884&rub_param=17

[28]http://www.mrdi.gov.ge/ge/news/press/53871b3f0cf2f176b8222cf3

[29]http://waste.gov.ge/admin/editor/uploads/files/2013%20-%20Six%20Month%20amosabechdi.pdf

[30]http://www.ambebi.ge/regionebi/78825-quthaisshi-akhali-nagavsayreli-2016-tslidan-amoqmeddeba.html

Kutaisi on territory adjacent to Terjola[31] 1.5 km from any populated settlements. This complies with international standards. Green cover will be planted to contribute to the environment.[32]

Fig. 19. Model of new Kutaisi landfill[33]

Waste waters

Municipal waste water is mostly generated at medical sites, in the services and industrial sectors and from homes, as well as the municipal engineering sector. During different water treatment stages-- physical, chemical, physical-chemical, bio-chemical or complex treatment-- some residues or solid admixtures are produced. Sewage residues are one of the most significant polluters of the environment which generate a huge spectrum of different harmful substances after decomposition, including significant amounts of greenhouse gases. Centralized sewage systems are operational only in 45 cities of Georgia. Most were constructed in the 1980s, do not meet technical standards and have frequent system malfunctions. Only 33 cities of Georgia have actually have sewage treatment plants that are operational, with a total estimated capacity of16,402,000 m^3/day. Most are outdated. Only 26 cities have biological treatment facilities, with a total estimated capacity of 14,766,000 m^3/day, however with the exception of Batumi and Gardabani, they are out of order and have ceased operations—this includes Kutaisi.[34]

Polluting waste waters are categorized as: water supply and sewage system – 344.1 million m^3/sec (67%); thermal energy generation – 163.8 million m^3/sec (31%); industry – 9.6 million m^3/sec (2%)[35]. The central collection system collects sewage waters in Kutaisi, while treatment is carried out at the Patriketi treatment plant where the facility occupies 14 ha and is operational since the 1980s.[36] It serves only Kutaisi.

[31]http://www.ambebi.ge/regionebi/78825-quthaisshi-akhali-nagavsayreli-2016-tslidan-amoqmeddeba.html
[32]http://www.mrdi.gov.ge/ge/news/press/52a3534be4b073169dbbb7ac
[33]http://www.waste.gov.ge/admin/editor/uploads/files/prezentacia%20parlamentistvis.pdf
[34]Only mechanical treatment is being carried out in Kutaisi.
[35]http://ekofact.com/2010/05/30/76/
[36]http://ekofact.com/2010/05/30/76/

One of the most acute problems of Kutaisi is pollution of surface waters with municipal, industrial, and drainage waters[37].In any of enterprises operational in Kutaisi the waste waters are not sufficiently treated, that leads to pollution of rivers with municipal and industrial waste. The most significant polluting factors for river Rioni - main sanitary artery of the city -is the Kutaisi municipal waste waters. The municipal waters flow to the Patriketi treatment plant, but due to its flawed operation, the waters from the collector flow directly to the river through the emergency drain inlet. River Rua crosses the city districts not equipped with sewage system. Municipal waters discharged to the river through the drain system cause significant pollution. Besides that the river is polluted with municipal waste.

Kutaisi provides a sewage system to 82% of its territory, although 40% of this needs rehabilitation.[38] The municipal waste water treatment plant is located in in the village of Patriketi in the Tskaltubo municipality but has not been properly operating for years (only mechanical treatment takes place). This is causing the pollution of the Rioni River.[39] The length of the Kutaisi sewage network is about 280 km and was constructed with different materials over the years, including ceramics, asbestos, ferroconcrete, cast iron, and polyethylene pipes. The diameter of the pipes varies from 150 mm to 1000 mm. The system is self-flowing , using gravity and connects to the ferroconcrete collector which is 17 km in length and 1.5 meters in diameter. Water flows to the Patriketi treatment plant from the collector.

Until 1990 mechanical, biological and chlorination treatments were carried out with a capacity iof 110,000 m^3/day). Today the plant only treats water mechanically at an average rate of 90 000 m^3/day, and this waste water is then discharged into Rioni River.[40] To reduce the impact of residual and commercial waste waters on environment, first of all, it is necessary to reconstruct the waste water treatment plant. This will increase the production of methane, however it will decrease pressure on the environment. Without reconstruction of the plant only small amounts of methane are released, however the first priority is a full reconstruction of the plant to mitigate all impact on the immediate environment-- soil and ground waters-- and only then can it be included Kutaisi Sustainable Energy Action Plan as a methane emission source.

Methodology

To calculate methane emissions from landfills two methods are suggested by IPCC guidelines: default (level 1) and FOD (First Order Decay) (level 2). The default method is a simple mass balance calculation which estimates the amount of CH4 emitted from the solid waste disposal sites (SWDS) assuming that all CH4 is released the same year as the waste was disposed. The other method outlined in the IPCC Guidelines is the FOD, which takes the time factors of the degradation process into account and produces annual emission estimates that reflect this process. This can take years, even decades. The default method can be successfully used if there is a constant amount and composition of waste disposed to a landfill, or if the variations are insignificant over several decades. Rapid changes in waste amounts and composition are evidently linked to carbon content, thus in such cases using the default method is not recommended.

To calculate methane emissions from the Kutaisi landfill the FOD method (level 2) was applied, with the relevant formulas and parameters given below.

[37]http://29skola.ucoz.com/news/zedap_39_iruli_ts_39_qlebi/2013-11-14-5
[38]http://nala.ge/uploads/kutaisi.pdf

[39]http://nala.ge/uploads/kutaisi.pdf
[40]ქ. ქუთაისის მერია

Level 2: First Order Decay Method (FOD)

Level 2: First Order Decay Method

$$M^{G}_{CH4}(t) = \sum_{x=1}^{x=t}[(A \bullet k \bullet MSW_T(x) \bullet MSW_F(x) \bullet MCF(x) \bullet DOC(x) \bullet DOC_F(x) \bullet F \bullet 16/12)] \bullet e^{-k(t-x)},$$

$$M^{E}_{CH4}(t) = [M^{G}_{CH4}(t) - R(t)] \bullet (1 - OX), \qquad (2)$$

Where:

$M^{G}_{CH4}(t)$ = is methane amount produced in t year, while $M^{E}_{CH4}(t)$ - is finally emitted methane amount

$MSW_T = Pop \bullet GR$.

MSW_T - is total Municipal Solid Waste

Pop –population number producing waste disposed to landfill

GR - municipal solid waste production norm

MSW_F - share of the Municipal Solid Waste in total waste disposed at landfill

MCF - methane correction factor

DOC - degradable organic carbon

DOC_F - fraction DOC dissimilated

F- fraction of CH4 in landfill gas

R - recovered CH4

OX- oxidation factor

t – year of inventory

x– previous year (with respect to)

$k=ln(2)/t_{1/2}$ - methane generation speed constant; $t_{1/2}$ - half-life

$\boldsymbol{A=(1-e^{-k})/k}$ - normalization coefficient correcting the sum calculation

Activity data

Waste being dumped or formerly dumped in landfills

According to data of the year of 2012, the population of Kutaisi was 196,600. After World War II the city population increased gradually, at a yearly average of 2.28%. Since 1989 it started decreasing by a yearly average of 1.73 % then since 2005 it showed an increasing trend though at a slower rate than the previous century (0.82% on average per year) (Table 40). Kutaisi's population density is 2,800 persons per square kilometer, exceeding 40 times the corresponding average

Table 40. **Factual, interpolated (*) and predicted demographic values for Kutaisi (2014 -2020)** includes actual, interpolated and predicted values of the population from 1956 to 2020.

Table 40. Factual, interpolated (*) and predicted[41] demographic values for Kutaisi (2014 -2020)

Year	Population number	Year	Population number	Year	Population number	Year	Population number	Year	Population, persons
1956*	111 269	1 969*	156 130	1982*	205 033	1 995*	211 028	2 008	188 600
1957*	113 846	1 970*	159 840	1983*	208 959	1 996*	207 447	2 009	190 700
1958*	116 423	1 971*	163 550	1984*	212 884	1 997*	203 867	2 010	193 600
1959	119 000	1 972*	167 270	1985*	216 809	1 998*	200 286	2 011	195 700
1960*	122 720	1 973*	170 980	1986*	220 734	1 999*	196 706	2 012	196 600
1961*	126 430	1 974*	174 690	1987*	224 660	2 000	193 126	2 013	196 500
1962*	130 140	1 975*	178 400	1988*	228 585	2 001	189 545	2 014	197 483
1963*	133 850	1 976*	182 120	1989	232 510	2 002	185 965	2 015	198 470
1964*	137 560	1 977*	185 830	1990*	228 930	2 003	184 300	2 016	199 462
1965*	141 280	1 978*	189 550	1991*	225 349	2 004	184 200	2 017	200 460
1966*	144 990	1 979	193 258	1992*	221 769	2 005	187 300	2 018	201 462
1967*	148 700	1 980*	197 183	1993*	218 188	2 006	189 900	2 019	202 469
1968*	152 420	1 981*	201 108	1994*	214 608	2 007	189 200	2 020	203 482

[41]Prediction for 2014-2020 have been made based an annual 0.5% increase, as used for other sectors.

According to data provided by the Municipality, 48,000 households are registered as users of the Kutaisi landfill, or approximately 114, 000 persons, that comprise 58% of Kutaisi's population. An additional 4300 subscribers are registered by the city garbage collection service database as commercial users, thus the total number of city landfill[42] users reaches 60% of the population.

In addition to this 60% of Kutaisi's population, waste from Tskaltubo and Bagdadi has been deposed in the landfill since 1994. For instance in 2012 the waste from these localities amounted to 18 000 m^3 and 12 000 m^3 correspondingly. Since precise demographic data on the population generating waste in these areas is not available, the total population of those municipalities was used as data. Based on Kutaisi data, the waste generated per person for 2012 was calculated at (200,000 m^3/(114,000+4300)=1.7 m^3) which equals 1.7 m^3, or 338 kg[43](1m^3-0.2 t). Based on the assumption that in 2012, the waste per person value in the region was the same, the number of persons in Tskaltubo (10,588) and Bagdadi (7058), who depose waste to the Kutaisi landfill in 2012 was calculated. For Tskaltubo in 2012 it was 14% of total population and for Bagdadi it was 24% (Table 41. Population of Tskaltubo and Bagdadi municipalities). Final results show that 45% (135,947 persons) of the total population (299,500) of all three towns deposed waste to the Kutaisi landfill.

Data on population rates in Tskaltubo and Bagdadi municipalities have only been available since 2002, and are presented in Table 41.

Table 41. Population of Tskaltubo and Bagdadi municipalities[44]

Municipality	Year Thousand persons														
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Bagdadi	NDA	NDA	29.2	29	28.7	28.4	29	28.8	28.6	28.5	28.7	28.8	28.8	28.6	28.5
Tskaltubo	NDA	NDA	73.9	73.4	72.9	72.7	73.9	73.6	73.2	73	73.6	73.8	74.1	73.6	73.5

NDA – No Data Available

[42]Commercial users are considered as regular citizens.

[43] Equals to 0.9 kg/day/person, close the same parameters in South European countries located at the same geographical latitude.

[44]http://www.geostat.ge

Characteristics of waste generation and disposal processes

The Kutaisi landfill serves city of Kutaisi, Tskaltubo[45] and Bagdagi[46] municipalities. According to 2012 data the Kutaisi landfill receives (population, industrial enterprises, other institutions) around 200 000 m^3 of waste from Kutaisi yearly, 18 000 m^3 from Tskaltubo municipality, and 12 000 m^3 from Bagdadi municipality.[47] Since 1994, the waste from Tskaltubo and Bagdadi was disposed of in the Nikea landfill. Based on this information, from 1956 until 1994 the landfill received waste generated only in Kutaisi. It has been calculated that in 1956 on 30% of the population generated the waste that was disposed of at the landfill. This percentage increased to 37% in 1993. An investigation conducted by GIZ (German development organization) in 2013 showed that the yearly amount of waste generated per person in Tbilisi was 271 kg, which is less than the European average for 2010 which was 524kg/person/year[48]. It was assumed that 271 kg of waste per person was a probable value for Kutaisi and for the region for the same period, including 2003. Kutaisi waste in 1956 – 1993 was calculated based on these assumptions, then in 1994 two more cities were included-– Tskaltubo and Kutaisi.

The amount of waste has increased over the last decade by 30% in Tskaltubo, by 500% in Bagdadi and 150% in Kutaisi.[49]

In 2000 the amount of waste was 150% times less than in 2012 (133,333 m^3) in Kutaisi; it was 30 % less in Tskaltubo (13,846 m^3), and 500% less (2400 m^3) in Bagdadi. Thus, the total amount in 2000 can be calculated at 149,579.5 m^3 (29 915 897 kg, 1m^3 – 0.2 t). Assuming that for this period a the amount of 271 kg of waste/person is valid, the total population supplying the landfill will number 110,391 (29 915 897/271), i.e., 37% of the population of all three cities. Taking into account that 37% of all three cities were connected to the landfill in 2000, an assumption was made that the waste generated by 25% of population of all three cities was disposed at the Kutaisi landfill. Waste per person is assumed to be 271 kg a year, including 2003. After 2003 the share number of persons contributing to the landfill has increased from 37% to 45% in 2012. Thus in 2012 the amount has increased to 338 kg, and it is predicted to be the same until 2020.

An increased ratio of population/use of landfills from 1956 to 2012 is calculated by a common interpolation method and adopting the above assumptions. Changes in the percentage of landfill users are presented in Table 43, showing that 1.3 million tons of waste has been disposited from1956 until 2012.

[45]http://nala.ge/uploads/ckaltubo.pdf
[46]http://nala.ge/uploads/bagdati.pdf
[47]Kutaisi City Hall
[48]The European environment – state and outlook 2010: Synthesis, European Environment Agency, Published: 29 Nov 2010, Copenhagen, p.73http://www.eea.europa.eu/soer/synthesis/synthesis
[49] Kutaisi City Hall

Table 42. Factual and interpolated amounts of population generating waste disposed at the Nikea landfill and the factual and interpolated amounts of waste disposed at the Nikea landfill

Year	Total population of each city				Population share generating waste disposed at the landfill		Waste, t
	Kutaisi	Bagdadi	Tskaltubo	Three cities	%	Sum	
1956	111 269	0	0	111 269	30	33 381	9 046.17
1957	113 846	0	0	113 846	30.19	34 369	9 314.05
1958	116 423	0	0	116 423	30.38	35 367	9 584.58
1959	119 000	0	0	119 000	30.57	36 375	9 857.75
1960	122 720	0	0	122 720	30.76	37 745	10 228.83
1961	126 430	0	0	126 430	30.95	39 125	10 602.88
1962	130 140	0	0	130 140	31.14	40 519	10 980.74
1963	133 850	0	0	133 850	31.32	41 928	11 362.41
1964	137 560	0	0	137 560	31.51	43 350	11 747.88
1965	141 280	0	0	141 280	31.7	44 790	12 138.01
1966	144 990	0	0	144 990	31.89	46 240	12 531.10
1967	148 700	0	0	148 700	32.08	47 705	12 927.99
1968	152 420	0	0	152 420	32.27	49 187	13 329.55
1969	156 130	0	0	156 130	32.46	50 679	13 734.06
1970	159 840	0	0	159 840	32.65	52 186	14 142.36
1971	163 550	0	0	163 550	32.84	53 707	14 554.47
1972	167 270	0	0	167 270	33.03	55 245	14 971.29
1973	170 980	0	0	170 980	33.22	56 793	15 391.01

1974	174 690	0	0	174 690	33.41	58 356	15 814.54
1975	178 400	0	0	178 400	33.59	59 933	16 241.88
1976	182 120	0	0	182 120	33.78	61 527	16 673.93
1977	185 830	0	0	185 830	33.97	63 132	17 108.88
1978	189 550	0	0	189 550	34.16	64 755	17 548.56
1979	193 258	0	0	193 258	34.35	66 387	17 990.94
1980	197 183	0	0	197 183	34.54	68 109	18 457.43
1981	201 108	0	0	201 108	34.73	69 845	18 927.94
1982	205 033	0	0	205 033	34.92	71 596	19 402.48
1983	208 959	0	0	208 959	35.11	73 362	19 881.15
1984	212 884	0	0	212 884	35.3	75 143	20 363.74
1985	216 809	0	0	216 809	35.49	76 939	20 850.35
1986	220 734	0	0	220 734	35.68	78 749	21 341.00
1987	224 660	0	0	224 660	35.87	80 575	21 835.76
1988	228 585	0	0	228 585	36.05	82 415	22 334.45
1989	232 510	0	0	232 510	36.24	84 270	22 837.17
1990	228 930	0	0	228 930	36.43	83 406	22 602.92
1991	225 349	0	0	225 349	36.62	82 527	22 364.90
1992	221 769	0	0	221 769	36.81	81 636	22 123.31
1993	218 188	0	0	218 188	37	80 730	21 877.95
1994	214 608	29 200	73 900	317 708	25	79 427	21 524.72
1995	211 028	29 200	73 900	314 128	27	84 815	22 984.75
1996	207 447	29 200	73 900	310 547	29	90 059	24 405.89
1997	203 867	29 200	73 900	306 967	31	95 160	25 788.30
1998	200 286	29 200	73 900	303 386	33	100 117	27 131.81
1999	196 706	29 200	73 900	299 806	35	104 932	28 436.60

2000	193 126	29 200	73 900	300 526	37	111 195	30 133.74
2001	189 545	29 200	73 900	296 945	37.75	112 097	30 378.22
2002	185 965	29 200	73 900	293 365	38.5	112 946	30 608.24
2003	184 300	29 000	73 400	291 000	39.25	114 218	30 952.94
2004	184 200	28 700	72 900	290 100	40	116 040	39 221.52
2005	187 300	28 400	72 700	292 700	40.75	119 275	40 315.03
2006	189 900	29 000	73 900	297 100	41.5	123 297	41 674.22
2007	189 200	28 800	73 600	295 900	42.25	125 018	42 256.00
2008	188 600	28 600	73 200	294 700	43	126 721	42 831.70
2009	190 700	28 500	73 000	296 500	43.75	129 719	43 844.94
2010	193 600	28 700	73 600	300 200	44.5	133 589	45 153.08
2011	195 700	28 800	73 800	302 600	45.25	136 927	46 281.16
2012	196 600	28 800	74 100	303 800	45.92	139 748	47 234.82

To identify future increases of waste generation, we calculated that besides a yearly 0.5% increase in population, there would be a 2% increase of population from all three cities connected to landfills, while waste generated per person would remain at 338 kg. With this assumption there are two scenarios: 1) the landfill is closed in 2016 and no waste is disposed after 2017, and 2) the landfill operates until 2020. Prediction calculations for both assumptions were carried out for the total population of all three cities and separately for the population using the landfill. Results are given in Table 43 and Table 44.

Table 43. Total population and population using the landfill increase until 2016, and then the landfill will be closed

Year	Factual (2012, 2013) and predicted population number	Factual (2012) and predicted number of population/user generating waste disposed to landfill		Factual (2012) and predicted waste amount (kg)
		%	People	
2012	303 800	45.92	139 505	46 000 000
2013	303 000	47.92	145 198	49 072 420

2014	304 515	49.92	152 014	51 376 303
2015	306 038	51.92	158 895	53 701 999
2016	307 568	53.92	165 841	56 049 667
2017	309 106	0	0	0
2018	310 651	0	0	0
2019	312 204	0	0	0
2020	313 765	0	0	0

Table 44. Total population and population using the landfill increase until 2020 and the landfill continues operating

Year	Factual (2012, 2013) and predicted population number	Factual (2012) and predicted number of population/user generating waste disposed to landfill		Factual (2012) and predicted waste amount (kg)
		%	People	
2012	303 800	45.92	139 505	46 000 000
2013	303 000	47.92	145 198	49 072 420
2014	304 515	49.92	152 014	51 376 303
2015	306 038	51.92	158 895	53 701 999
2016	307 568	53.92	165 841	56 049 667
2017	309 106	55.92	172 852	58 419 469
2018	310 651	57.92	179 929	60 811 568
2019	312 204	59.92	187 073	63 226 128
2020	313 765	61.92	194 283	65 663 312

Waste composition

Comprehensive/precise data on the composition of municipal waste is not available. The only available data is composition percentages, which comes from a single survey conducted in Tbilisi (2013, GIZ) and Batumi (EU) municipalities. There are certain differences between the waste compositions of these two cities as Batumi is a touristic city. Also the waste of Batumi and Kutaisi would differ significantly, so Tbilisi data was used for calculations (2003, GIZ). There are other sources for waste composition, but all of them are based on 2003 data. According to some sources, waste composition has changed compared to 1989-1990, and in particular the percentage of organic waste (paper, carton) and metal has decreased, while plastic is significantly higher[50] (Table 45).

Table 45. Composition of municipal waste in Tbilisi[51]

Fraction	1990	kg	
	m^3 [52]	2003 [52][53]	2010 [52]
Paper	34	5	6
Plastic material	2	6	6
Inert material	4	5.5	5
Mixed	NDA	1	1
Metal	5	3	3
Green waste	NDA	3	3
Hygienic waste	NDA	2	2
Textiles/leather	5	3	3
Small/residue	8	27.8	NDA
Organic waste	42	43.7	71

Table 45 shows that for 1990 and 2003 there is a percentage of waste consisting most probably of organic substances (while comparing data of 2003 and 2010, it can be seen that the sum of small/residue and organic percentage in 2003 equals to the organic percentage in 2010). Calculations were made based on the assumption that the small/residue and organic percentages in 1990 and 2003 are united in one organic percentage in 2010.

[50] http://geocities-tbilisi.ge/failebi/2388-Introduction.pdf

[51] 2003 - "2003, GIZ" ; 1990 and 2010- "*GEO*-cities Tbilisi: Integrated Assessment of State and Trends in Capital of Georgia";http://geocities-tbilisi.ge/failebi/2388-Introduction.pdf

[52] Kutaisi City Hall

[53] GIZ, Analysis of waste produced in Tbilisi, 2003

Data of 1990[54] given in volume units were transformed into weight units[55], while for the interim years the data were interpolated. Table 46 presents the interpolated data on waste composition for different years that was used for calculation.

[54] http://geocities-tbilisi.ge/failebi/2388-Introduction.pdfand GIZ, Analysis of waste produced in Tbilisi, 2003

[55] Mean density of waste fractions: paper –63kg/m^3; plastic–55kg/m^3;

Inert material- 435kg/m^3; metal–165kg/m^3; textile/leather– 56kg/m^3; organic waste– 330kg/m^3 (GIZ, Analysis of waste produced in Tbilisi, 2003)

Table 46. Waste composition (factual data for 1990, 2003, and 2010 and interpolated data for the rest of the years)

Year	Mass of fraction								
	Paper	Plastic material	Inert material	Metal	Textile leather	Organic waste	Mixed	Green waste	Hygienic waste
1990	10.5	0.5	8	4	1.4	75.6	0	0	0
1991	10.08	1	7.85	3.92	1.52	75.28	0.04	0.23	0.15
1992	9.65	1.4	7.7	3.85	1.65	74.97	0.08	0.46	0.31
1993	9.23	1.8	7.55	3.77	1.77	74.65	0.12	0.69	0.46
1994	8.81	2.2	7.4	3.69	1.89	74.34	0.15	0.92	0.62
1995	8.38	2.6	7.25	3.62	2.02	74.02	0.19	1.15	0.77
1996	7.96	3	7.1	3.54	2.14	73.71	0.23	1.38	0.92
1997	7.54	3.4	6.95	3.46	2.26	73.39	0.27	1.62	1.08
1998	7.12	3.8	6.8	3.38	2.38	73.08	0.31	1.85	1.23
1999	6.69	4.2	6.65	3.31	2.51	72.76	0.35	2.08	1.38
2000	6.27	4.6	6.5	3.23	2.63	72.45	0.39	2.31	1.54
2001	5.85	5	6.35	3.15	2.75	72.13	0.42	2.54	1.69
2002	5.42	5.4	6.2	3.08	2.88	71.82	0.46	2.77	1.85
2003	5	6	6	3	3	71.5	0.5	3	2
2004	5.14	6	5.86	3	3	71.43	0.57	3	2
2005	5.29	6	5.71	3	3	71.36	0.64	3	2
2006	5.43	6	5.57	3	3	71.29	0.71	3	2
2007	5.57	6	5.43	3	3	71.21	0.79	3	2
2008	5.71	6	5.29	3	3	71.14	0.86	3	2
2009	5.86	6	5.14	3	3	71.07	0.93	3	2
2010	6	6	5	3	3	71	1	3	2

Since waste management in Georgia is in the initial stages are no reliable data on waste composition especially data for separate cities. The best solution is to calculate the Kutaisi greenhouse emissions from solid waste disposal sites, based on Tbilisi data. The large part of organic waste according to Table 46 would potentially increase GHG production and methane generation. Theoretical and practical work carried out by the Institute of Hydrometeorology of the Technical University of Georgia at the new landfill in Tbilisi (Norio) showed that though results of theoretical data were quite high, the real measurements of methane produced were even a bit higher.[56]

Thus, it can be suggested, that despite the different composition of waste in different countries, the investigation data on composition of waste generated in Georgia and the selected default values are close to actual data.

Emission factors

Several factors are used to calculate methane emissions from solid waste:

Methane Correction Factor – MCF - depends on the landfill type. Unmanaged landfills produce less methane than managed ones because decomposition of most waste in the upper layers takes place in aerobic conditions, releasing carbon dioxide. IPCC 1996[57] gives default values of the correction factor inTable 47.

Table 47. Default values of methane emission correction factor (MCF) for different landfill types

Landfill type/landfill	Average thickness of waste (m)	MCF
Managed[58]		1
Managed-thin[59]	Waste thickness <5 m	0.5
Unmanaged – deep	Waste thickness>5 m	0.8
Unmanaged – shallow	Waste thickness <5 m	0.4
Uncategorized landfills		0.6
Kutaisi	**15**	**0.8**

[56]Report on greenhouse gas emissions in Georgia, 2006 – 2011

[57]1996 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/gl/pdffiles/rusch6-1.pdf(p. 6.8)

[58]A Managed landfill is an area where waste is disposed and kept under control (waste is disposed at specially prepared areas where it is protected from self-ingition). Waste is covered, rammed and disposed in layers. Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000, p. 5.9

[59]2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (p.3.16)

The Kutaisi landfill, like most of the landfills in Georgia (except in Tbilisi and Rustavi), is unmanaged, and is deep. The 12 -15 m-deep landfill has no drainage system; no systematic waste treatment or even soil cover. Sometimes construction waste from the city is disposed at the landfill. The only treatment measure conducted at the landfill is packing the garbage with Komatsu bulldozers. Since the Kutaisi landfill belongs to an unmanaged category, it is deeper than 5m (>5) even up to 15m. Thus a methane correction factor 0.8 was taken for calculations (Table 47).

Degradable organic carbon – DOC

Degradableorganic carbon (DOC) a constituent part of waste which decomposes biochemically, and is measured in mg - C /mg. The value of DOC depends on waste composition and climate conditions. IPCC guidelines were used to calculate DOC values for the waste component.[60] And DOC values according to waste composition are given in Table 48.

Table 48. DOC values according to waste composition

Waste composition	DOC
Food waste	0.15
Garden	0.2
Paper	0.4
Wood and straw	0.43
Textiles	0.24
Single use hygine pads	0.24

Fraction of degradable organic carbon dissimilated -DOC_F

Some organic carbon does not degrade, or degrades very slowly. IPCC GPG presents recommended values for DOC_F– 0.5 – 0.6 (in this case it is supposed that there are anaerobic conditions at the landfill and the DOC_F value also contains lignin[61] carbon). DOC_F value depends on many factors such as temperature, humidity, pH, waste composition, etc. According to IPCC GPG, it is recommended to use national values, though they should be based on a well-documented survey.

[60] 2006 IPCC Guidelines for National Greenhouse Gas Inventories http://www.ipcc-nggip.iges.or.jp/public/2006gl (p. 2.16)

[61]Plant cells contain three significant components: cellulose, lignin, and hemicellulose. Lignin supplies cell walls and connects cells. Decomposition of lignin is an aerobic process. Lignin decomposition in anaerobic conditions is a very long process.

For maximum uptaking/degradability of lignin-cellulose-containing substances the Van Soest logarithmic-linear relation was used basing on Barla's experimental data.[62] For mixed waste (municipal solid waste) DOC_F was calculated using the formula:

$DOC_F = (DOC_1 \bullet DOC_{F1} + DOC_2 \bullet DOC_{F2} + \cdots + DOC_N \bullet DOC_{FN}) / DOC,$

where N is the number of different waste types.

$\boldsymbol{(DOC_F)_{w/o\ lignin}}$ was calculated using the formula[63]:

$(DOC_F)_{w/o\ lignin} = DOC_F \bullet DOC / DOC_{w/o\ lignin}.$

For calculations we used IPCC 2006 level2 software, which automatically calculates all necessary parameters.

Content of methane in landfill gas (F)

According to IPCC 2006, the content of methane in landfill gas is 50% of the volume. Only oil- and fat-containing material produces bio-gas with a higher content of methane. The oxidation coefficient (OX) denotes the quantity of methane produced in the material used for covering the waste (soil, or other). In cases of managed landfills (where waste is covered by oxidizing substances like soil or compost) OX equals 0.1, while in unmanaged landfills OX = 0.[64] Accordingly, for the Kutaisi landfill it was assumed that OX = 0.

Baseline year inventory and greenhouse gas emissions base scenario (2012-2020)

According to the project of the Solid Waste Management Company, the Kutaisi landfill will be closed in 2016 and methane emissions will consequently be decreased. Table 49 shows preditions for methane emissions after closing the Kutaisi landfill (2016). The calculations have been conducted based on the assumption that the existing waste would remain at the landfill and methane would not be utilized.

Table 49. Nikea landfill and methane emission in 2012 – 2036 (in case of closing in 2016)

Year	Gg/Year	Kg/Year	m³/Year	m³/day
2012	1.76	1 757 700.00	2 441 250.00	6 688.36
2013	1.82	1 818 000.00	2 525 000.00	6 917.81
2014	1.88	1 882 600.00	2 614 722.22	7 163.62

[62] Chandler, J.A., W.J. Jewell, J.M. Gossett, P.J. Van Soest, and J.B. Robertson. 1980. Predicting methane fermentation biodegradability. Biotechnology and Bioengineering Symposium No. 10, pp. 93-107; Richard T. The Effect of Lignin on Biodegradability."Cornell Composting - Science & Engineering, 1996, www.css.cornell.edu/compast/calc/lognin.htme

[63] Chandler, J.A., W.J. Jewell, J.M. Gossett, P.J. Van Soest, and J.B. Robertson. 1980. Predicting methane fermentation biodegradability. Biotechnology and Bioengineering Symposium No. 10, pp. 93-107; Richard T. The Effect of Lignin on Biodegradability."Cornell Composting - Science & Engineering, 1996, www.css.cornell.edu/compast/calc/lognin.htme

[64] Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000, p. 5.10. http://www.ipcc-nggip.iges.or.jp/public/gp/english/index.html (p.5.10)

2015	1.95	1 953 400.00	2 713 055.56	7 433.03
2016	2.03	2 029 600.00	2 818 888.89	7 722.98
2017	2.11	2 110 600.00	2 931 388.89	8 031.20
2018	1.81	1 809 300.00	2 512 916.67	6 884.70
2019	1.56	1 555 800.00	2 160 833.33	5 920.09
2020	1.34	1 342 200.00	1 864 166.67	5 107.31
2021	1.16	1 162 000.00	1 613 888.89	4 421.61
2022	1.01	1 009 700.00	1 402 361.11	3 842.09
2023	0.88	880 700.00	1 223 194.44	3 351.22
2024	0.77	771 200.00	1 071 111.11	2 934.55
2025	0.68	678 100.00	941 805.56	2 580.29
2026	0.6	598 800.00	831 666.67	2 278.54
2027	0.53	530 900.00	737 361.11	2 020.17
2028	0.47	472 700.00	656 527.78	1 798.71
2029	0.42	422 700.00	587 083.33	1 608.45
2030	0.38	379 600.00	527 222.22	1 444.44
2031	0.34	342 300.00	475 416.67	1 302.51
2032	0.31	309 800.00	430 277.78	1 178.84
2033	0.28	281 600.00	391 111.11	1 071.54
2034	0.26	256 800.00	356 666.67	977.17
2035	0.24	235 100.00	326 527.78	894.6
2036	0.22	215 900.00	299 861.11	821.54

According to this data (Table 49), it can be suggested that if the project is implemented and if the landfill is closed in 2016, then methane emissions from the closed landfill in 2020 will be 1.34 Gg. If the landfill continues to operate, methane emissions from the operational landfill will be 2.38 Gg by 2020 (Table 50).

Table 50. Methane emissions from Nikea landfill in 2012 – 2016 (in case of continued operation)

Year		Kg/Year	m^3/Year	m^3/Day
2012	1.76	1 757 700.00	2 441 250.00	6 688.36
2013	1.82	1 818 000.00	2 525 000.00	6 917.81
2014	1.88	1 882 600.00	2 614 722.22	7 163.62
2015	1.95	1 953 400.00	2 713 055.56	7 433.03
2016	2.03	2 029 600.00	2 818 888.89	7 722.98
2017	2.11	2 110 600.00	2 931 388.89	8 031.20
2018	2.2	2 195 700.00	3 049 583.33	8 355.02
2019	2.28	2 284 700.00	3 173 194.44	8 693.68
2020	2.38	2 376 900.00	3 301 250.00	9 044.52
2021	2.47	2 472 200.00	3 433 611.11	9 407.15
2022	2.58	2 577 000.00	3 579 166.67	9 805.94
2023	2.69	2 690 600.00	3 736 944.44	10 238.20
2024	2.81	2 812 400.00	3 906 111.11	10 701.67
2025	2.94	2 942 100.00	4 086 250.00	11 195.21
2026	3.08	3 079 300.00	4 276 805.56	11 717.28
2027	3.22	3 223 800.00	4 477 500.00	12 267.12
2028	3.38	3 375 300.00	4 687 916.67	12 843.61
2029	3.53	3 533 800.00	4 908 055.56	13 446.73
2030	3.7	3 699 100.00	5 137 638.89	14 075.72
2031	3.87	3 871 300.00	5 376 805.56	14 730.97
2032	4.05	4 050 200.00	5 625 277.78	15 411.72
2033	4.24	4 236 000.00	5 883 333.33	16 118.72

2034	4.43	4 428 700.00	6 150 972.22	16 851.98
2035	4.63	4 628 400.00	6 428 333.33	17 611.87
2036	4.84	4 835 100.00	6 715 416.67	18 398.40

Action Plan for decreasing emissions from the solid waste sector in Kutaisi

In the Kutaisi Sustainable Energy Action Plan only one measure is envisaged for the landfill management sector – establishing a system for collecting and burning methane at the existing landfill. The implementation of this measure would replace methane (CH_4) emissions with the release of carbon dioxide (CO_2) into the atmosphere, which are a less dangerous greenhouse gas. The decreased amounts of emissions are calculated for the two cases considered, closing the landfill in 2016, or continuing operations. It was assumed that the establishment of a system for collection and burning of methane would take place in 2016.

Table 51. Amount of CO2 saved by implementing each proposed project.

Year	Gg/Year							
	Closing in in 2016				Operation continues			
	CH_4	CO_2eq	CO_2produced by burning of 80% of CH4	Saved CO_2	CH_4	CO_2eq	CO_2produced by burning of 80% of CH4	Saved CO_2
2012	1.76	36.96	0	0	1.76	36.96	0	0
2013	1.82	38.22	0	0	1.82	38.22	0	0
2014	1.88	39.48	0	0	1.88	39.48	0	0
2015	1.95	40.95	0	0	1.95	40.95	0	0
2016	2.03	42.63	0	0	2.03	42.63	0	0
2017	2.11	44.31	4.64	39.668	2.11	44.31	4.64	39.66
2018	1.81	38.01	3.98	34.028	2.2	46.2	4.84	41.36
2019	1.56	32.76	3.43	29.328	2.28	47.88	5.01	42.86
2020	1.34	28.14	2.94	25.192	2.38	49.98	5.23	44.74
2017-2020	6.82	143.22	15	128.21	8.97	188.37	19.73	168.63

Total								

If the first scenario is developed, CO_2 emissions will be decreased by 25 Gg (89%), while if the second scenario takes place, CO_2will be decreased by 45 Gg (89,5%). In calculating this data, two assumptions have been made: first, that actually only 80% of methane can be collected and second, that while burning one ton of methane, 2.75 tons of CO_2 would be released into the atmosphere. If the landfill is closed in 2916, a total of 128 Gg of CO_2 will be reduced, or 89.5%.

Table 52. CO_2 equivalent of the methane emitted from Kutaisi landfill in 2012 – 2020 (without measures undertaken) and CO_2 amount in case of measures undertaken according to two scenarios

Measure	**CO_2, Gg**		
	2012	**2020**	
	Operation	**Scenario1** **Closed in 2016**	**Scenario 2** **Operating**
Not undertaken	36.96	28.14	49.98
Undertaken		2.94	5.23

Green Spaces

Sector Overview

The State of Kutaisi's environment has significantly worsened in recent years. One of the reasons is the continuing loss of green cover that began in the 1990s. City traffic is congested, especially in the center, causing additional problems for the environment.

The total area of Kutaisi recreational zones covers 221.4 ha. Public gardens compose 4 ha (4 units), public squares make up 20.4 ha (107 units), one park is 7 ha, other city lawns compose 21.4 ha and one Botanical Garden has an area of 14.7 ha. The green cover at city cemeteries occupies 88.8 ha and green areas adjacent to private houses, residential buildings, offices and institutions compose a total of 65.1 ha. About 140 thousand bushes and trees are found in recreational areas, most frequently Plane, Aspen, Zelkova, Cedar, Cypress, Willow, and Palm, most of which were planted in the 1950s and 60s. A comprehensive inventory has not been conducted and data available today is not precise. Data from the Botanical Garden is more or less complete while data on other recreational areas is poor and scattered. Due to this lack of data, percentages of wood trees where significant biomass is concentrated were used for calculations.

Percentages for the main tree species in Kutaisi recreational zones (excluding the Botanical Garden) are given below:[65]

- Plane (Platanus orientalis) - 34%, 70 ha;
- Aspen (Populus)- 19%, 39 ha;
- Cedar (Cedrus deodara)- 13%, 27 ha;
- Pine (Pinus pinaster)- 10%, 21 ha;
- Cypress (Cupressus sempervirens)- 9%, 18 ha;
- Other trees- 15%, 31 ha.

The Botanical Garden covers two separately registered areas - one located at 2, Leselidze Street (7.5 ha) and another near the Hotel Khvamli (7.2 ha). The core area of the Botanical Garden is at Leselidze Street and located on the right bank of the Rioni River. It occupies three terraces adjacent to the river. The first of these terraces is not planted, because there was no dam to protect the Garden area from the river. The river has regularly flooded the first terrace, resulting in part of the terrace and initial 70 m buffer zone between the Garden and the river being washed out and decreased to 15 -20 m. The main part of the Botanical garden covers 7.05 ha (See Fig. 20). A total of about 5 ha of the whole territory is planted while the rest is occupied by administrative buildings, an amphitheatre, a greenhouse, a nursery, public squares and pathways, etc. The core area of the Garden is surrounded by some 8.9 ha free areas (along the river), where a 5-ha forest-park is planned.

Fig. 20. Orthophoto of Botanical Garden with contours of planted areas

Among all plants represented in the Kutaisi Botanical garden, 160 species are evergreen trees and bushes and 518 species are deciduous plants.

[65] According to Kutaisi City Hall data

The most common species found in the Botanical Gardens of Kutaisi [66]:

- Oriental plane (Platanus orientalis)
- Zelkova (Zelkova serrata)
- European spruce (Picea excelsa)
- Evergreen cypress (Cupressus sempervirens)
- Caucasian hornbeam (Carpinus caucasica)
- Japanese spindle (Euonymus japonica)
- Persian ironwood(Parrotia persica)
- Montezuma cypress (Taxodium mexicanum)
- Evergreen sequoia (Sequoia sempervirens)
- Japanese cedar (Cryptomeria japonica)
- Sweet viburnum (Viburum odoratissimum)
- False camphor cree (Cinnamomum glanduliferum)
- Southern magnolia (Magnolia grandiflora)
- Horse chestnut (Aesculus hippocastanum)
- Japanese quince (Chaenomeles japonica)
- Crepe myrtle (Lagerstroemia indica)

Among the above listed plants woody trunk trees should be separately noted, because they contain a significant amount of the total biomass of the Garden. These are: Plane, Zelkova, Horse chestnut, European spruce, Evergreen sequoia and Caucasian hornbeam.

Methodology

The carbon accumulation and absorption potential of the green cover in Kutaisi and Botanical Garden in the baseline year of 2012 is assessed in IPCC Good Practice 2003, using the given methodology.[67] As for the city greening works - in the later years, increase of the carbon accumulation potential was evaluated using the CO2FIX model.[68]

IPCC Methodology

We used the IPCC-methodology for calculating living biomass (including underground biomass). In particular, we calculated the volume of carbon in the accumulated biomass and its subsequent increase area by using the following equations:

1. The equation used to determine carbon reserves accumulated in the live biomass (both underground and above-ground):

$$\Delta C_{F_{LB}} = [V \bullet D \bullet BEF_2] \bullet (1+R) \bullet CF$$

[66] Data received from the administration of Botanical Garden

[67]Good Practice Guidance for Land Use, Land-Use Change and Forestry, http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

[68] http://dataservices.efi.int/casfor/frontpage.htm

where:

V - Wood volume, m3/ha;

D - Volume weight of the totally dry wood, tons of dry mass/m3;

BEF2-Coefficient for converting commercial wood stock into total stock of the above-ground wood plants (including crowns), for further determination of live above-ground biomass.

R - Ratio of root mass to the tree trunk;

CF -Carbon portion in dry substance, ton C/ton dry mass.

2. The equation for calculation of annual increment in carbon store of the biomass:

$\Delta C_{F_G} = (A \cdot G_{TOTAL}) \cdot CF$

where:

$\Delta C_{F_{G-}}$ is annual increment of carbon store caused by increase of the biomass, t C/year;

A – area covered by wood plants;

G_{TOTAL} – average annual rates of total biomass increment, tone of dry mass/ha/year;

$G_{TOTAL} = G_W \cdot (1+ R)$,

where:

R - is ratio of plant root mass to trunk.

G_W–aboveground biomass increment, t/dry weight.

When G_W–are not available, the following equation should be used for calculation:

$G_W = I_V \cdot D \cdot BEF_I$,

where:

I_V is biomass average annual increment, m^3/ha/year;

D – volume weight of totally dry wood, tone of dry weight/m^3;

BEF_I- coefficient for converting average annual increment into the total above-ground biomass

Model CO2FIX V 3.1

CO2FIX model was elaborated within the CASFOR II project. CASFOR II was funded by the INCO2 Program of the European Commission. Dutch Ministry of Agriculture, Nature and Food Quality and Mexican National Council on Science and Technology (CONACYT) also supported the project.

The CO2FIX V 3.1 model determines carbon accumulation volumes in nature by using a so-called accounting methodology. In particular, the model calculates changes in carbon stores in all carbon "reservoirs" of the forests within a concrete period of time (the carbon "reservoir" is a part of nature where carbon is stored, such as live biomass, earth mass, organic soils, and also processed wood resources).

Calculations in the six main modules of the CO2FIX V 3.1 model are carried out for one year and one hectare:

1. Biomass module;

2. Soil module;

3. Production module;

4. Bio-energy module;

5. Financial module;

6. Carbon credits counting module (for CDM).

According to the model methodology, carbon accumulation volume (CTt) in each (t) period is calculated as follows:

$C_{Tt} = C_{bt} + C_{st} + C_{pt}$ (Mg C/ha)

Where:

C_{b_t}- total amount of carbon in aboveground and underground biomass of a plant (Mg C/ha);

C_{s_t} - carbon stocks in organic soils (Mg C/ha);

C_{p_t}- carbon stocks in the processed wood products (Mg C/ha)

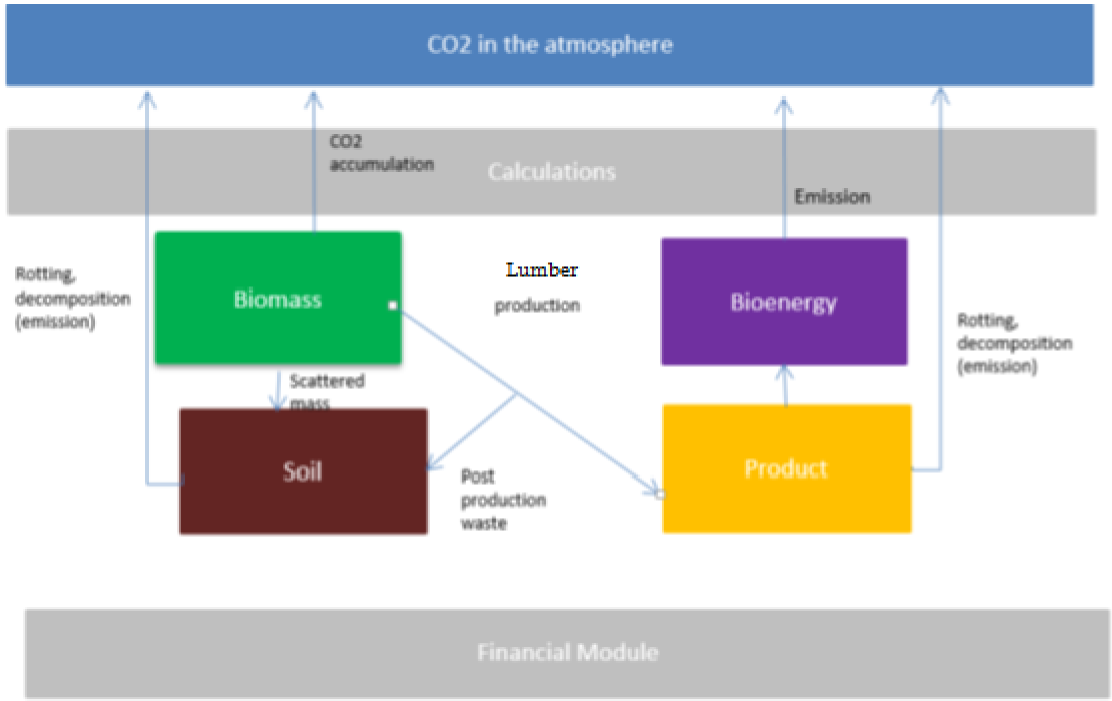

Fig. 21. Model structure

According to the project scenario (rehabilitation/ planting), two modules have been used for calculation: biomass and soil modules.

Biomass module

The biomass module uses a "cohort system", where each cohort consists of one or more wood plant species groups. It is defined as a group of individual trees or as a group of species that are assumed to exhibit similar growth, drying and other features, and which may be treated as single entities within the model.

Table 53. Necessary and used characteristics in biomass modules according to the project scenario

List of characteristics used in biomass module	Characteristic values
Biomass carbon content	0,5 t C /t dry mass
Wood density, t dry mass	
Poplar	0.353
Cypress	0.542
Paulownia	0.280

Acacia	0.770
Tuya	0.290
Magnolia	0.460
Hornbeem	0.620
Oleander	0.255
Initial carbonstock	0tC/ha
Growth correction factor	1.00
Turnover rate	
Conifers	
Needles	0.30
Branches	0.04
Root	0.03
Deciduous	
Leaves	1.00
Branches	0.05
Roots	0.08

Soil module

YASSO was chosen as an approach to define carbon dynamics in the soil module (http://www.efi.fi/projects/yasso/). The model (included in CO2FIX) describes carbon decay and its dynamics in dry soil. It is calibrated to detect total carbon stock in any soil layers. This model is suitable for coniferous as well as for deciduous forests and was tested in different countries and climate zones to describe the influence of different climate conditions on the decomposition processes of fallen leaves and branches.

Table 54 Parameters used in soil module

Parameters used in soil module	Value
Total of above-zero temperature during the year (C^{O})	4 150.0
Evapotranspiration (PET,mm)	510.0
Precipitation volume during vegetation(mm);	1 205.0
Monthly average temperature during vegetation period	
March	8.0
April	11.5
May	12.0
June	21.0
July	22.5
August	22.8
September	19.2
October	15.0

Baseline year inventory

Calculations of carbon reserves and increments using the above equations have been conducted separately for the green zones of the Kutaisi municipality and the Botanical Garden. Some coefficients for calculations in Kutaisi recreational zones have been taken from data obtained during the inventory for forest planning, performed in 2009 in forest districts adjacent to Kutaisi under the administration of the Imereti Regional Forestry Department.

For fragmented planting areas (a total of 195.6 ha) within the city recreation zone (221.4 ha) data, 50 -60 year-old sparse forest stands have been included. For closed canopy stands in recreational zones (11 ha within the city and 5 ha in the Botanical Garden, or 16 ha in total), medium density forest data have been used (50– 60 year-old trees for city greening and 80-120-year old trees for the Botanical Garden). For these calculations, an average annual increment and wood plant stock data has been created (see Table 54. Coefficients used for calculations). To calculate weighed values / suspended index of the wood volume weight (D), dominant wood plants stock has been used. Other coefficients (BEF_1, BEF_2, R, CF) were taken from IPCC methodology, specifically, from the standard index list corresponding to the Imereti region's climate.

Table 54. Coefficients used for calculations

Indexes suitable for calculations	Kutaisi green cover (fragmented and closed canopy stands)		Kutaisi Botanical Garden closed canopy stand
	Fragmented	Closed canopy	
A-Green cover area , ha[69]	195.60	11.00	5.00
V- Wood plant stock m3/ha[70]	47.00	108.00	250.00
D-volume weight of totally dry wood, tone totally dry mass[71] / m^3	0.579	0.590	0.610
I_V- Wood plant mean annual increment, m^3[72]	1.40	1.80	2.30
BEF_1- Coefficient for conversion of wood mean increment into total aboveground (including crown) mean increment [73]	1.15	1.15	1.15
BEF_2- Coefficient for conversion of commercial wood stock into the total stock of aboveground wood plants (including crown), for calculating further the aboveground living biomass.[74]	1.30	1.30	1.30
R-Ratio of root mass to sprout[75]	0.24	0.24	0.24
CF-carbon share in dry wood[76]	0.50	0.50	0.50

[69] Kutaisi City Hall Administration

[70] Imereti Regional Forestry Department, 'Forest Use Plan', 2009

[71] "Global Wood Database" http://datadryad.org; Makhviladze E. Wood Science Tbilisi 1962; Boroviko A.M., Боровиков А.М., Ugolev B.N. Уголев Б.Н. " Wood Catalogue" "Timber Industry" Moscow 1989;

[72] Taxation indicators for Batumi plants and trees; Invetory of Adjara Forest 2004.

[73]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10,http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf;

[74]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.10;

[75]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003),Table 3A1.8http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_files/GPG_LULUCF_FULL.pdf;

[76]Good Practice Guidance for Land Use, Land Use Change and Forestry, (IPCC 2003).http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.html

Calculation data for recreational zones are given in Table 55.

Table 55. Accumulated carbon and annual absorption at the project sites

Kutaisi recreational zones	Recreational zones covered with plantings (ha)	Carbon accumulated in area of 1 ha tC	Carbon accumulated in the city recreational zones tC	Annual deposit of carbon/carbon dioxide		
				Carbon annual sequestration in 1 ha tC	Carbon annual sequestration	Carbon dioxide annual sequestration tCO2
Zones covered by fragmented planting	195.60	21.60	4 224.90	0.57	112.50	412.50
Zones covered by closed canopy planting	11.00	51.40	565.40	0.75	8.25	30.20
Botanical Garden	5.00	123.00	615.00	0.95	4.75	17.40
Total weighted average		25.50		0.59		
Sum	211.60		5 395.80		125.50	460.20

Calculations for each site (Botanical Garden, recreational zone, etc.) are presented separately:

Accumulated and annually incremented Carbon in recreation zones of Kutaisi, with fragmented planting (195.6 ha)

Accumulated stocks

$\Delta C_{F_{LB}}$= [V●D●BEF$_2$] ●(1+R) ●CF =[47●0.57●1.3] ●(1+0.24) ●0.5= 34.8●1.24 ●0.5=**21.6** t**C/**ha**,**

Hence, (195.6 ● 21.6**)=4 225.0tC**is accumulated in Kutaisi recreational zones (fragmented)

Sequestration

Annual carbon sequestration in (fragmented) Kutaisi recreational zones (195.6 ha)

$\Delta C_{F_G}=(A \cdot G_{TOTAL}) \cdot CF$= 195.6 · 1.15 · 0.5=**112.5tC**

$G_{TOTAL} = G_W \cdot (1+ R)=0.93 \cdot 1.24=1.15;$

$G_W= I_V \cdot D \cdot BEF_I=1.4 \cdot 0.579 \cdot 1.15=0.93;$

Hence, annual sequestration in 1 ha recreational zones is **0.57tC/ha**.

<u>Carbon accumulation and annual sequestration in Kutaisi recreational zones, in particular, in closed canopy plantings of 11 ha.</u>

Accumulated stocks

$\Delta C_{F_{LB}}= [V \bullet D \bullet BEF_2] \bullet (1+R) \bullet CF =[108 \bullet 0.59 \bullet 1.3] \bullet (1+0.24) \bullet 0.5= 82.8 \bullet 1.24 \bullet 0.5=$**51.4tC/ha,**

In recreational (11 ha) zones (closed canopy plantings) is accumulated(11●51.4**)-565.4 tC.**

Sequestration

Annual carbon sequestration in recreational (11 ha) zones (closed canopy plantings) :

$\Delta C_{F_G}=(A \cdot G_{TOTAL}) \cdot CF= 11 \cdot 1.5 \cdot 0.5=$**8.25tC**

$G_{TOTAL} = G_W \cdot (1+ R)=1.2 \cdot 1.24=1.5$

$G_W= I_V \cdot D \cdot BEF_I=1.8 \cdot 0.59 \cdot 1.15=1.2$

Hence, annual carbon sequestration (closed canopy plantings) in 1 ha of recreational zones is **0.75tC/ha**

<u>Carbon accumulation and annual sequestration in Botanical Garden, in particular in closed canopy plantings of 5 ha.</u>

Accumulated stocks

$\Delta C_{F_{LB}}= [V \bullet D \bullet BEF_2] \bullet (1+R) \bullet CF =[250 \bullet 0.61 \bullet 1.3] \bullet (1+0.24) \bullet 0.5= 198 \bullet 1.24 \bullet 0.5=$**123tC/ha;**

Hence, annual carbon accumulation in Botanical Garden (5 ha) is (5●123**)-615 tC**

Increment

Annual sequestration in Botanical Garden (5 ha):

$\Delta C_{F_G}=(A \cdot G_{TOTAL}) \cdot CF= 5 \cdot 1.9 \cdot 0.5=$**4.75tC**

$G_{TOTAL} = G_W \cdot (1+ R)=1.6 \cdot 1.24=1.9$

$G_W= I_V \cdot D \cdot BEF_I=2.3 \cdot 0.61 \cdot 1.15=1.6$

Hence, annual sequestration in Kutaisi Botanical Garden per 1 ha is **0.95tC/ha**.

An increase of the sequestration potential as a result of greening works conducted by Kutaisi City Hall in 2014 as well as works planned for the following years (greening of street curbs (1 ha), forest-park in Botanical Garden (5 ha), and various recreational areas of the city (1 ha), has been assessed using CO2FIX model. A preliminary budget has been composed for each of these works to be carried out within the project proposals. The data calculated has been compared to 2012 baseline year data in the summarizing chapter.

Kutaisi greening action plan

An annual carbon sequestration potential has been calculated based on the above data, taking into account works conducted by the Kutaisi City Hall in 2014, as well as the greening works planned for the future.

Activity 1 (Greening of recreational areas planned by the Kutaisi City hall for 2014)

Plans to plant 1250 saplings in different recreational areas of Kutaisi (total area of 1 ha). A detailed budget of greening works is presented in Table 56.

Table 56. Greening works planned for 2014 in Kutaisi[77]

List of planned works	Quantity	Unit price	Total Price	Total (one year)
Planting decorative tree saplings	1250	5.00	6,250.00	6,250.00
Spruce. Height 2.2-2.5m	10	80.51	805.10	805.10
Acacia dealbata. Height 2.2-2.5m	30	8.56	256.80	256.80
Cypress. Height 2.2-2.5m	20	53.65	1,073.00	1,073.00
Pink Crepe Myrtle. Height 2.0-2.2m, with min 3-4 stems	30	27.40	822.00	822.00
Magnolia stellata. Height 1.5-1.8m	0	-	-	-
Paulownia (decorative). Height 2.0-2.3m	60	28.90	1,734.00	1,734.00
Prunus. Height 2.0-2.2m	0	-	-	-
Tuia (decorative). Height 1.0-1.1m	250	42.37	10,592.50	10,592.50

Carbon accumulation data is given in Table 57. Carbon accumulation dynamics for the next 70 years is plotted according to the model (Fig. 22). There will be some decrease in accumulation for several species due to necessary trimming (for instance, poplar tress over 50 years old need trimming).

Table 57. Carbon accumulation and carbon dioxide sequestration indexes after planned greening activities in 2014.

[77] Kutaisi City Hall Public Amenities Service

year [yr]	Sequestered Carbon reforestation carbon [MgC/ha]	Sequestered Carbon reforestation CO2 equiv. [MgCO2eq...	year [yr]	Sequestered Carbon reforestation carbon [MgC/ha]	Sequestered Carbon reforestation CO2 equiv. [MgCO2eq...	year [yr]	Sequestered Carbon reforestation carbon [MgC/ha]	Sequestered Carbon reforestation CO2 equiv. [MgCO2eq...	year [yr]	Sequestered Carbon reforestation carbon [MgC/ha]	Sequestered Carbon reforestation CO2 equiv. [MgCO2eq...
1	1.81	6.64	22	74.96	274.84	43	132.01	484.04	64	145.30	532.76
2	4.16	15.27	23	78.42	287.55	44	134.40	492.81	65	144.34	529.25
3	7.03	25.79	24	81.77	299.83	45	135.64	497.33	66	143.74	527.04
4	9.99	36.62	25	85.01	311.69	46	137.73	505.02	67	143.45	526.00
5	12.94	47.45	26	88.14	323.18	47	139.99	513.30	68	143.44	525.96
6	15.93	58.43	27	91.18	334.33	48	142.27	521.65	69	143.62	526.60
7	19.00	69.65	28	94.15	345.21	49	144.53	529.96	70	143.97	527.91
8	22.14	81.17	29	97.03	355.79	50	144.93	531.39			
9	25.47	93.39	30	99.85	366.12	51	146.75	538.09			
10	29.02	106.42	31	102.60	376.21	52	148.83	545.70			
11	32.75	120.10	32	105.30	386.10	53	150.91	553.34			
12	36.63	134.31	33	107.95	395.80	54	153.01	561.02			
13	40.63	148.98	34	110.52	405.23	55	152.64	559.69			
14	44.62	163.59	35	113.02	414.41	56	154.38	566.04			
15	48.58	178.12	36	115.46	423.35	57	156.46	573.68			
16	52.51	192.53	37	117.84	432.08	58	158.55	581.35			
17	56.42	206.86	38	120.17	440.64	59	156.60	574.19			
18	60.31	221.15	39	122.52	449.22	60	151.93	557.07			
19	64.11	235.08	40	124.87	457.85	61	149.55	548.36			
20	67.82	248.66	41	127.24	466.55	62	147.86	542.15			
21	71.42	261.89	42	129.62	475.28	63	146.46	537.01			

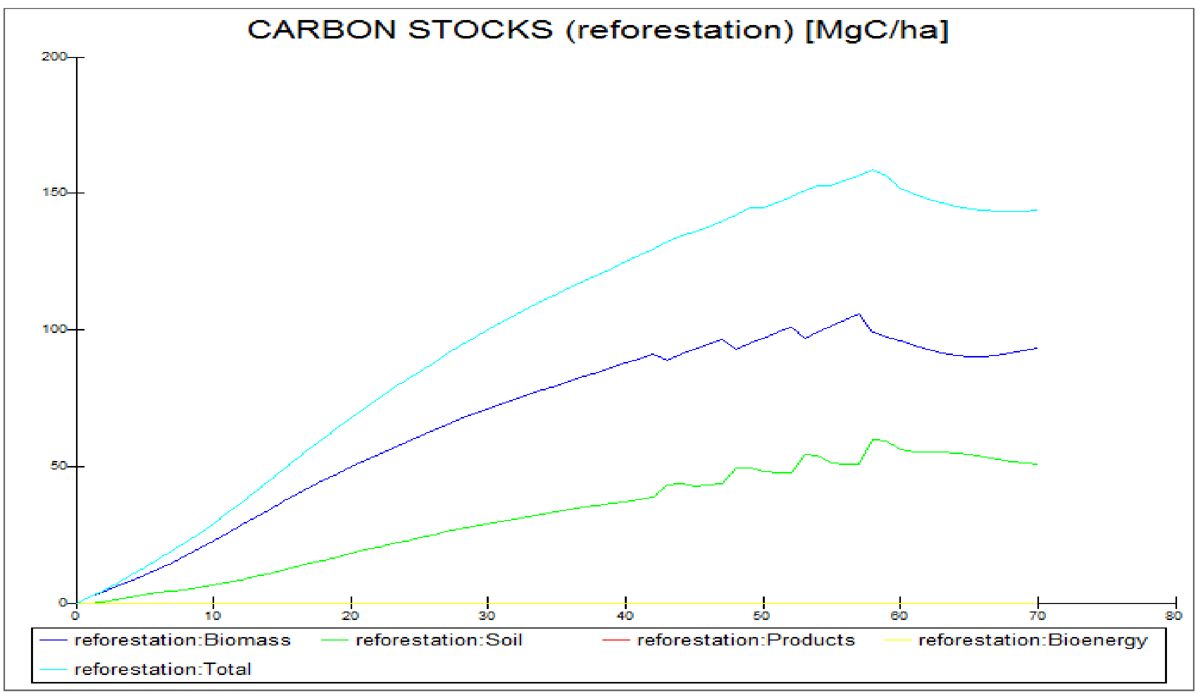

Fig. 22. Carbon accumulation dynamics after planting works (2014)

The summarized data from the model shows that 1.8 t C will be accumulated per hectare during the first year of planting. Carbon accumulation data until 2020 is given in

Table 58.

Table 58. Carbon accumulation of annual data per hectare after greening works in 2014

	2014	2015	2016	2017	2018	2019	2020
Accumulated carbon t C	1.80	4.20	7.00	10.00	13.00	16.00	19.00
Sequestrated carbon dioxide t CO_2	6.60	15.30	25.80	36.60	47.40	58.40	69.60

Activity 2 Greening street curbs in Kutaisi

It is planned to carry out greening along city street curbs by planting 400 wood plants of the first size category at a distance of 5 m apart for a total of 1 ha (5X2000 m). The budget of this Activity is presented in

Table 59. The annual accumulation of carbon has been calculated according to the model.

See also Table 60 and Fig. 23. Carbon sequestration dynamics.

Table 59. Budget for street curb greening works

№	Expenditure	Unit	Cost per unit (US $)	Total amount	Total cost (US $)
I. Core expenditure					
1	Planting material				
1.1	Wood trees of first size	Units	95	400	38 000
2	Field work				
2.1.	Marking area and digging holes	Sapling	0.6	400	240
2.2.	Planting and nurturing	Sapling	0.4	400	160

2.3.	Watering	Sapling	0.1	400	40
	Total				**38 440**

As it is shown in the Table, planting wood trees will cost $38,440 or the equivalent of approximately 67 270 GEL (1 GEL = $1.75).

Table 60. Carbon accumulation and carbon dioxide sequestration.

	Sequestered Carbon reforestation	Sequestered Carbon reforestation		Sequestered Carbon reforestation	Sequestered Carbon reforestation		Sequestered Carbon reforestation	Sequestered Carbon reforestation		Sequestered Carbon reforestation	Sequestered Carbon reforestation
year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...
1	0.40	1.48	22	29.59	108.49	43	67.41	247.18	64	65.79	241.25
2	1.01	3.69	23	31.35	114.94	44	69.00	253.02	65	63.38	232.39
3	1.81	6.64	24	33.14	121.52	45	70.56	258.74	66	61.28	224.70
4	2.79	10.22	25	34.97	128.23	46	72.09	264.35	67	59.60	218.53
5	3.91	14.32	26	36.83	135.04	47	73.60	269.86	68	58.29	213.72
6	5.15	18.87	27	38.71	141.94	48	75.08	275.28	69	57.28	210.04
7	6.50	23.84	28	40.61	148.92	49	76.53	280.61	70	56.45	207.00
8	7.96	29.19	29	42.54	155.97	50	77.90	285.62			
9	9.51	34.86	30	44.45	162.97	51	78.95	289.49			
10	11.05	40.50	31	46.34	169.92	52	80.13	293.80			
11	12.56	46.07	32	48.22	176.81	53	81.26	297.95			
12	14.06	51.54	33	50.08	183.63	54	82.32	301.85			
13	15.53	56.96	34	51.92	190.39	55	83.33	305.54			
14	17.01	62.36	35	53.75	197.10	56	84.28	309.04			
15	18.49	67.80	36	55.57	203.75	57	85.19	312.36			
16	19.99	73.28	37	57.37	210.35	58	86.05	315.53			
17	21.50	78.83	38	59.16	216.90	59	86.88	318.54			
18	23.04	84.46	39	60.93	223.40	60	81.43	298.58			
19	24.60	90.18	40	62.66	229.75	61	75.92	278.37			
20	26.21	96.09	41	64.15	235.23	62	71.91	263.65			
21	27.87	102.20	42	65.79	241.22	63	68.61	251.56			

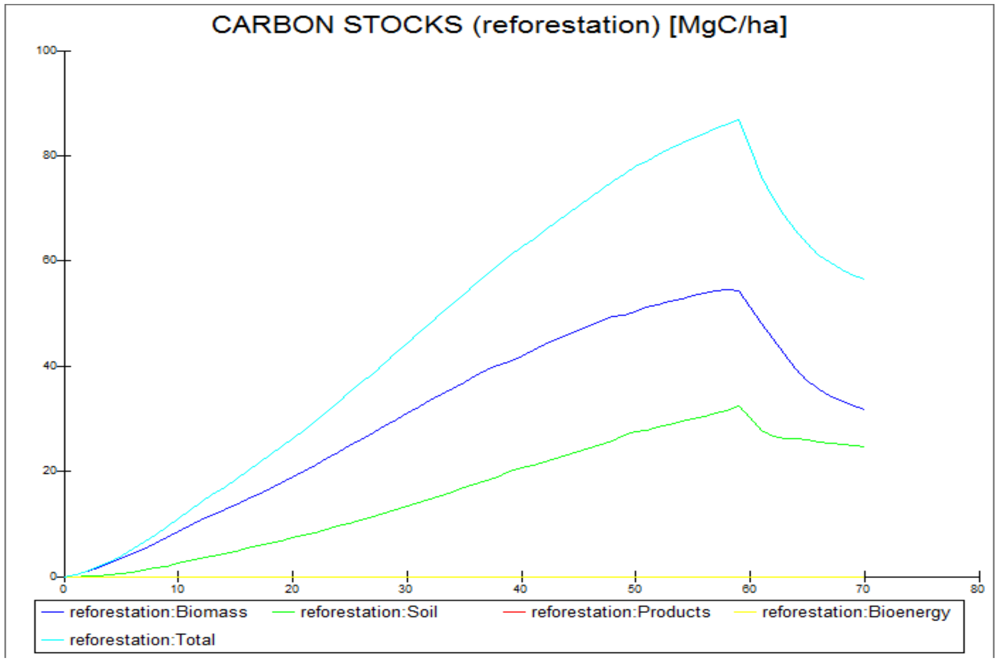

Fig. 23. Carbon sequestration dynamics

Data obtained according to the model show that 0.40 t C per hectare will be accumulated during the first year of the planned work. Accumulated data until 2020 is presented in Table 61.

Table 61. Annual carbon accumulation data after conducting the planned greening of street curbs (per ha)

	2014	2015	2016	2017	2018	2019	2020
Accumulated carbon t C	0.40	1.00	1.80	2.80	3.90	5.20	6.50
Sequestrated carbon t CO_2	1.50	3.70	6.60	10.20	14.30	18.90	23.20

Plans have been made to establish a forest-park and a plant nursery in Kutaisi as described below.

Activity 3. Plan for the development of a free area of the Botanical Garden (5 ha) and to establish a nursery (2 ha).

The project area of 5 ha of the Botanical Garden is adjacent to the core territory of the Garden and extends to the banks of the Rioni River. Two different types of landscape will be created on this territory – a classic landscape with public commons and lawns and an arboretum. The project area will be a natural extension of the Botanical Garden core area and represent a single dendrological park. For this, plants for the project area should be selected according to their botanical or geographical characteristics. The plan is to select species according to the classification of floristic districts and as appropriate as possible for the natural landscape.

Prior to the greening works a project for planting will be developed that includes topographical maps of the park infrastructure, schemes, lists of species to be planted and a budget. The initial work plan and relevant budget will be provided in the report. Of the five hectares allocated, 80% will be planted, while the remaining hectare will be used for lawns, trails, roads, public squares or other infrastructures.

Varieties of plats will be planted at appropriate distances from each other, for example the distance between trees of first size category will be 5 m, between the second category trees – 4 m, and between the third category trees – 3 m. The first category which require the most light will cover 20% of the total area (0.8 ha); second category plants, which require shade will be planted on 35% of the total area (1.4 ha) and the third category trees and bushes will be planted on 45% of total area (1.8 ha). Planting material should be at least 7-10 years old with well developed crown and root systems. The root system of coniferous plants must be tightly packed into the earth.

Taking into account the distances between plants, the following number of saplings will be needed:

- First size category wood plants – 97 pieces;
- Second size category wood plants – 880 pieces;
- Third size category wood plants – 1980 pieces.

A total of 2957 saplings will be needed to cover the 4 ha of the project area. While selecting varieties habitat requirements must be taken into account. Budget for planting of wood plants at the project area is given below in the Table 62.

Table 62. Budget for planting works

№	Expenditure description	Unit	Price per unit (US $)	Total amount	Total price (US $)
I. Core expenditure					
1	Planting material				
1.1	Largest wood plant saplings	Pieces	95	97	9 215.0
1.2	Second largest wood plant saplings	Pieces	35	880	30 800.0
1.3	Third largest plant saplings	Pieces	25	1980.0	49 500.0
Subtotal 1:				2 957.0	89 515.0
2	Field works				
2.1.	Clearance of planting area (from thicket, coppice, etc.)	ha	110	5	550
2.2.	Marking area and digging holes.	Sapling	0.5	2 957.0	1 479.0

2.3.	Planting saplings	Sapling	0.2	2 957.0	591
2.4.	Watering planted saplings	Sapling	0.1	2 957.0	296
Subtotal 2:					2 916.0
Total (USD)					**92 431.0**

As Table 62 show, planting wood plants will cost $92,431 -- equivalent to 161,754 GEL (1 GEL = $1.75).

Two units will be located on two different plots for the nursery. One of them (0.7 ha) will serve as a seed/sapling receiver (0.5 ha) and grafting area (0.2 ha), while the other will be in charge of seed/sapling re-planting. For example two-year-old saplings grown in the first nursery (0.7 ha) will be re-planted in the second unit (1.3 ha) at a distance of 1-2 m apart, to develop more before finally being set out in their final destination within the greening project. Saplings nursed in the greenhouse or containers will also be re-planted in this unit. The budget to create the nursery and planting units is presented in Table 63) and includes main expenditures for the first stage, followed by nurturing works of the second stage. Saplings of some exotic species like eucalyptus and palm can only be grown in greenhouses, where they should stay at least two years. Once they are two years old they can be transferred outside and then considered as standard, developed saplings.

At the current stage, the price for the certified seed of only one wood specimen (*Tilia caucasica*) is given in the nursery budget. The planting norm for this species is 450 kg of seeds per 1 ha.[78] In our project we need 225 kg of certified seeds of Tilia (0.5 ha). For grafting we have selected only one specimen, the Evergreen privet (*Ligustrum semrevirens*). The grafting norm for this specimen is 75,000 grafts per hectare, and we will need 15,000 grafts for 0.2 ha within our project.

Table 63. Suggested budget to create the nursery (0.7 ha)

№	Expenditure description	Size unit	Cost per unit (US $)	Total amount	Total cost (US $)
1	Purchase				
1.1	Seed material (*Tilia caucasica*)	kg	20	225	4,500.0
1.2	Grafting material (*Ligustrum semprevirens*)	Pieces	0.08	15,000	1200.0
Subtotal 1:					5700.0

[78] Tristan Cherkezishvili, Forest planting in Georgia, 1986.

2	Field works				
2.1.	Clearance (from thicket, copies, etc.)	Ha	110	0.7	77
2.2.	Ploughing (autumn)	Ha	100	0.7	70
2.3	Harrowing (spring)	Ha	50	0.7	35
2.4	Sowing	Ha	55	0.5	28
2.5	Grafting	Pieces	0.15	15, 000.0	2 25.0
2.6	Watering sown and grafted areas	Ha	150	0.7	105
Subtotal 2:					2565.0
Total (USD)					**8265.0**

Table 64. Suggested budget for creating the planting department

№	Expenditure description	Size unit	Price per unit (US $)	Total amount	Total price (US $)
I. Core expenditure					
1	Field works				
1.1	Clearance (from thicket, coppices, etc.)	ha	110	1.3	143
1.2	Ploughing (autumn)	ha	120	1.3	156
1.3	Harrowing (spring)	ha	50	1.3	65
1.4	Planting 2-year-old saplings from nursery	Pieces	0.1	55,000.0	5500.
1.5	Watering	Pieces	0.05	55,000.0	2750.0
Total (USD)					**8614.0**

Expenditures for planting the project area is 161,754 GEL; expenditures for nurseries: for the first unit (0.7 ha) – 14,464 GEL and for the second unit (1/3 ha) – 15,075 GEL (1 GEL – 1.75 US$).

Carbon sequestration data after planting the 5 ha area is presented in Table 65. Sequestration dynamics are shown by the curve in Fig. 24. Carbon sequestration dynamics after planting.

Table 65. Carbon sequestration after greening works and carbon dioxide absorption.

	Sequestered Carbon reforestation	Sequestered Carbon reforestation		Sequestered Carbon reforestation	Sequestered Carbon reforestation		Sequestered Carbon reforestation	Sequestered Carbon reforestation		Sequestered Carbon reforestation	Sequestered Carbon reforestation
year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...	year [yr]	carbon [MgC/ha]	CO2 equiv. [MgCO2eq...
0	0.00	0.00	21	117.07	429.26	42	193.55	709.69	63	246.69	904.52
1	3.61	13.24	22	121.92	447.05	43	196.34	719.90	64	249.16	913.58
2	8.46	31.03	23	126.64	464.35	44	199.05	729.86	65	251.62	922.61
3	14.49	53.12	24	131.14	480.86	45	201.71	739.60	66	254.08	931.62
4	20.56	75.40	25	135.45	496.63	46	204.31	749.12	67	256.53	940.62
5	26.47	97.07	26	139.56	511.73	47	206.85	758.44	68	258.98	949.59
6	32.30	118.43	27	143.52	526.23	48	209.34	767.57	69	261.37	958.36
7	38.14	139.84	28	147.33	540.22	49	211.83	776.69	70	263.70	966.91
8	44.05	161.52	29	151.06	553.90	50	214.32	785.84			
9	49.94	183.11	30	154.72	567.31	51	216.82	795.00			
10	55.88	204.90	31	158.32	580.50	52	219.32	804.18			
11	61.77	226.49	32	161.86	593.49	53	221.83	813.37			
12	67.58	247.79	33	165.35	606.29	54	224.33	822.55			
13	73.31	268.81	34	168.77	618.81	55	226.83	831.71			
14	79.00	289.66	35	172.10	631.05	56	229.33	840.86			
15	84.65	310.38	36	175.37	643.03	57	231.82	849.99			
16	90.27	330.99	37	178.58	654.78	58	234.30	859.09			
17	95.87	351.53	38	181.72	666.32	59	236.78	868.19			
18	101.46	372.02	39	184.79	677.57	60	239.26	877.29			
19	106.85	391.80	40	187.78	688.54	61	241.74	886.38			
20	112.06	410.88	41	190.70	699.24	62	244.22	895.46			

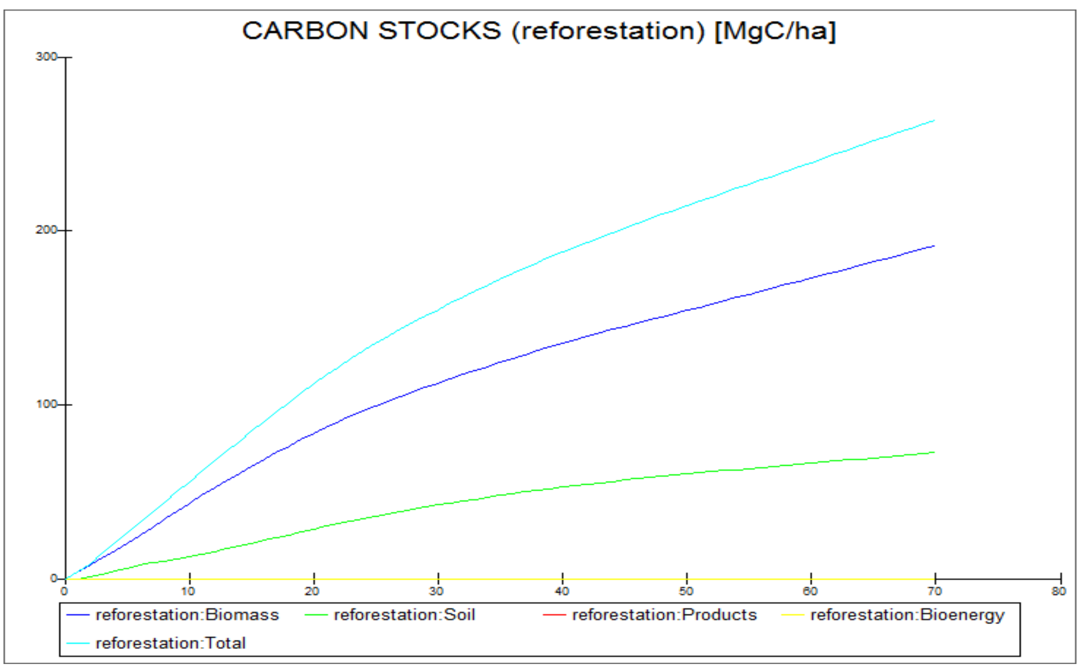

Fig. 24. Carbon sequestration dynamics after planting.

As Table 66-

Table 68 show, 3.6 t C/ha will be sequestrated during the first year of the planned planting works.

Table 68 presents the sequestration data until 2020.

Table 66. Annual sequestration data after planting the forest-park (1 ha) in the Botanical Garden

	2014	2015	2016	2017	2018	2019	2020
Sequestrated carbon, t C	3.60	8.50	14.50	20.60	26.50	32.30	38.10
Carbon dioxide absorption, t CO_2	13.30	31.00	53.10	75.40	97.10	118.40	139.80

Outcomes

Table 67. Carbon sequestration potential after planned greening activities in Kutaisi

Planned activities	**Annual carbon sequestration t C**						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Carbon sequestration after the planned greening activities by the City Hall (2014); project budget: 6250 GEL	1.80	4.20	7.00	10.00	13.00	16.00	19.00

Carbon sequestration due to greening of street curbs (1.3 ha in total); project budget: 67,270 GEL	0.40	1.00	1.80	2.80	3.90	5.20	6.50
Carbon sequestration after creating a forest-park in the Botanical Garden (4 ha); project budget: 161,754 GEL	14.40	34.00	58.00	82.40	106.00	129.20	152.40
Total	16.60	39.20	66.80	95.20	122.90	150.40	177.90

Table 68. Carbon sequestration in Kutaisi recreational areas and potential carbon sequestration developed by planned greening works.

	Annual carbon sequestration t C								
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Carbon sequestration in the city recreational areas without conducting any greening activities	5,395.80	5,396.30	5,396.90	5,397.50	5,398.10	5,398.70	5,399.30	5,399.90	5,400.50
Annual carbon sequestration after conducting greening activities	-	-	16.60	39.20	66.80	95.20	122.90	150.40	177.90
Total carbon sequestration after conducting proposed measures in recreational areas of the city	5,395.80	5,396.30	5,413.50	5,436.70	5,464.90	5,493.90	5,522.20	5,550.30	5,578.40

The strategy for raising awareness and promoting environmental education for Kutaisi's population and target groups concerning the perspectives for developing sustainable energy in Kutaisi, as well as its economic and social outcomes.

Sustainable development of the energy sector in a country, region or municipality is a field where the involvement of state and community structures is equally important, and where all parties should be equally interested in success. To raise public awareness on renewable energy sources, a mix of energy efficiency and energy saving activities with a multilateral approach should be developed. A communications strategy is one of the key parts of an action plan such as SEAP's. The SEAP preparation process within the framework of the Covenant of Mayors (CoM) revealed some of the main barriers that could prevent strategy implementation. It is important to evaluate all identified barriers and develop ways to overcome them.

During the evaluation process three main barriers have been found:

1. Those at the country level or national scale that are remnants of past practices. This is especially true in the field of awareness, but also includes the current economic and social situation and a deficiency in technological know-how.
2. Barriers specific to Kutaisi.
3. Barriers related to specific project proposals and related technologies.

Barriers for implementing a sustainable energy development strategy in Georgia

Wasteful consumption in the energy sector
Originates from Soviet times, as energy was very cheap and consumption was almost unlimited, thus wasteful.

Insufficient awareness on sustainable development in general
Few citizens are involved in this field or are aware of the concept;
There is an absence of a common vision on medium or long term perspectives for energy sector development. Different target groups still have significantly different standpoints, often not based on relevant or reliable calculations.

1**. Absence of a common, well analysed and extensive view on the role of energy efficiency and renewable energy resources for a short- or long-term perspective concerning the energy sector in Georgia.** There is a 10% averagen annual increase in energy demand yet the general potential or strategy have not been defined, except for hydro energy. A legislative basis for energy has not been developed and goals are not established like it has for gas use or hydropower.

2. The market for innovation and new technology is risky. An operational failure of every new technology or a pilot project has a significant impact on further development perspectives. The availability of technologies is not taken into account enough while planning for long term tasks in the energy sector.

3. **NGOs work on energy efficiency and renewable energy (except hydro) in an uncoordinated and untargeted way.** Although there are some positive shifts in energy efficiency in the country, they are chaotic. This can be explained by the introduction of modern technologies like household appliances and international energy standards into the general Georgian market.

While identifying these barriers, certain circumstances have been taken into account. Although the Kutaisi municipality administration has its sights set on further perspectives for sustainable energy development, frequent changes in leadership slow down the whole process.

Barriers to Kutaisi's sustainable energy development:

1. One of the main barriers in the entire Imereti region is common to all regions and municipalities of Georgia, including Kutaisi: **A total dependence on a central energy supply in the electricity sector and the full dependence on the private sector for other energy.** This dependence is partial in the gas supply sector, where municipalities mainly depend on supplies planned by central authorities. Petrol, diesel, and other fuels are all the prerogative of private importers.

2. Kutaisi does not collect statistical data on energy consumption in the city that would permit planning for increased demand. There is no vision or strategy in case the city's energy supply system breaks down. There is no real awareness of the necessity for efficient energy use or its role in the sustainable social-economic development of the city. No vision or strategy exists for possible problems that may arise as the country's economy grows.

3. The Kutaisi municipality does not have sufficient **experience, knowledge or human resources** for planning or managing the processes of sustainable energy development.

4. **There is an absence of budgeted funding for sustainable energy development** as most resources are directed to infrastructure development and social projects.

5. **The field of energy consumption is unmanaged and chaotic** at the municipal level, as well as nationwide. All these barriers are common to the whole country, and thus relevant for Kutaisi to a different extent.

In addition to these barriers related to local development and to the import and distribution of technology, there are other barriers related to each separate technical field that should be taken into account when assessing applied technologies during the implementation of SEAP.

Barriers connected to technologies :

1. **Lack of knowledge in modern energy-efficient and renewable technologies, existing and available on the international market.** Only a few technologies have been tested for their adaptation to Georgian conditions. This significantly increases the risks for introducing them. Neither private banks nor the private sector are willing to take financial risks thus only the non-governmental sector or investors who benefit from expanding coverage for their own technologies will agree to introduce new technologies. Often the quality of imported technology is low, especially since higher quality implies greater cost.
2. **Lack of knowledge about local conditions** where new technology is to be introduced. For instance, energy efficient lamps are totally ineffective and disadvantageous in case of old and improperly operating electric networks. Additional funds have to be allocated to conduct relevant assessments and adjustments.
3. **Lack of knowledge on environmental and social counter-indications.** Those using new tools or skills need to know how to assess technical risks, to avoid and minimize them.
4. **Lack of properly educated local human resources,** who would be able to select appropriate technologies, adaptable to local conditions, and deploy them. Lack of such resources is even more specific for municipalities and self-governing cities.
5. **Most renewable technologies are not sufficiently flexible and easily adaptable to different environments.** Most are not marketable and additional funds and knowledge are needed for adapting them to a given environment.

An analysis was carried out to identify parties and target groups interested in awareness raising and retraining. These target groups should have intensive training tobe able to deal with the barriers to introduction of new technologies. Since some barriers are common to the whole country it will be very hard to address them without significant involvement of the central authorities. The target groups considered in the present strategy include the Kutaisi municipality staff and Kutaisi city council members; the Kutaisi population and private sector. Special attention should be paid to the industry sector.

An information campaign to raise public awareness is crucial for carrying out the Action Plan. All the population should understand the aims of the sustainable energy action plan, as well as the positive social and economic consequences it will bring. When it becomes necessary to change certain habits and behavior to ensure maximum support from the population, they should be involved in the process of developing an action plan. It has been shown in other countries that the higher the involvement of the local population in the earlier stages, the easier it will be to carry out and manage change.

At the initial stages of SEAP's implentation, meetings and consultations should be organized with the Kutaisi population and representatives from different sectors, especially those where there is a higher need for behavior change. The advantages of planning change and the benefits for the city and its population should be clearly explained at these meetings. Consultations are useful for gathering new ideas and project proposals as well (for instance, attitudinal assessments of Kutaisi residents and trends in behavior change), as they can be considered for modifying planned activities.

The strategy for awareness raising and training specialists and future experts for Kutaisi's SEAP implementation includes two stages:

Short term strategy (2014-2018)

1. Provide local authorities with the information on the advantages of sustainable energy consumption and the social and economic benefits of this initiative.
2. Training for municipality staff and external resources to implement and monitor the SEAP
3. Assess behavior, attitude and information awareness of the Kutaisi population. Identify, planning and develop recommendations on behavior change trends that will ensure successful implementation of the information-education campaign.
4. Carry out an information-education campaign, to raise awareness. Prepare information/education/illustration materials about successful experiences and modern technologies that are used for the green development of cities; demonstrate (pilot) the advantages of energy efficient measures and technologies for population.
5. Ensure the involvement of the private sector when carrying out the sustainable energy action plan by presenting energy-saving and economically profitable technologies and by proposing cooperation programs with the public sector.

Long term strategy (2018-2020)

1. Initiate consultations with interested parties (city population, private sector, non-governmental sector) on restriction measures and standards to be compiled by the municipality in different sectors (construction, transport, waste generation) to identify barriers that may appear during the process of introducing any new restrictions and standards.
2. Develop and implement awareness raising and incentive programs for different target groups to ensure a smooth introduction of the standards (e.g. energy efficiency).

Strategy of Kutaisi Municipality in the field of education and awareness rising for the successful implementation of SEAP

Main strategic goals	**Main target groups**	**Measures to be implemented**	**Potential leading organization(s)**	**Outcome**	**Potential donors**
Short term strategic goals (2014-18	Kutaisi Municipality and City Council	The first and main goal of short term strategy is to create the awareness of the city authorities about the perspectives for sustainable energy consumption and its social and economic benefits. It will provide maximum information and awareness for the population; and will provide assistance to the population for receiving maximum benefits from this initiative, while providing specialists/ future experts with training to ensure proper implementation and monitoring of the action plan.	Kutaisi City Hall	Kutaisi SEAP is successfully implemented	Kutaisi City Hall
	Kutaisi population		Coordinators of the Covenant of Mayors in Georgia (Ministry of Energy and Ministry of Environment and Natural Resources Protection)	Kutaisi City hall continues the same activity after 2020.	Coordinators of the Covenant of Mayors in Georgia (Ministry of Energy and Ministry of Environment and Natural Resources Protection)
			Local and international ongoing programs within the framework of the COM, and initiatives on the preparation of low emissions development strategies	The Kutaisi population is informed on initiatives launched by the city authorities	Local and international programs within the framework of the COM, and initiatives on the preparation of low emissions development strategy

					International donors supporting climate change mitigation, renewable energy, energy efficiency and sustainable development processes.

1. Education of specialists				
Education of technical staff of Kutaisi who conduct qualified work and elaborate technical recommendations for successful implementation of the Covenant of Mayors	• Kutaisi City Hall technical group • Special service established by Kutaisi City Hall (e.g. Energy Efficiency Center), which would provide services as for the City Hall, and for population and private sector.	• Establish special technical group/service within or outside of Kutaisi City Hall, which will work for the City Hall on implementation and monitoring of the SEAP, as well as on promoting modern technologies among the city population and private sector. • Develop the program to prepare the technical group. The program should reflect the requirements of sustainable energy, climate change mitigation measures, EU directives, Covenant of Mayors and an analysis of barriers existing for	• Kutaisi City Hall • Ministry of Energy • Ministry of Environment and Natural Resources Protection • Representation of the Covenant of Mayors process in Georgia (at current stage – Energy Efficiency Center)	• Develop program and manual on preparation of specialists for the City Hall technical group • Specialists are prepared and selected on a tender basis • Responsibilities and working program for selected specialists are clearly defined to envisage assistance to the City Hall, and work with the population and private sector • A Technical group is actively involved in exchange programs and

		introduction of modern technologies • Prepare manuals for technical groups • Insert the technical group members into exchange programs and different information networks for sharing international experience • Potential candidates for the technical group should be involved as much as possible in developing SEAP at early stages.		international networks to obtain the latest information on modern technologies and approaches in the energy sector • The Technical group is ready to prepare necessary specialists for the private sector

2. Public information and awareness raising					
The public should receive social and economic benefits due to increased sustainable energy development. At the first stage of awareness-raising, a survey on Kutaisi population behavior patterns, attitudes and knowledge in this field will be conducted. A survey will identify the potential for involvment. Based on the results, information campaigns will be planned and implemented. The main activity of the City will be to provide consultations on energy efficiency measures in buildings; latest technologies available and best practices.	• House owners cooperatives • Non-governmental sector • Other public associations	• Prepare information material for population on those technologies and measures, which will improve the environment and allow to reduce energy consumption • Prepare information about Kutaisi (e.g. what potential the city has for energy efficiency and	• Kutaisi City Hall • Non-governmental sector	• TV spots and information booklets for Kutaisi population • TV spots and information booklets are prepared for Kutaisi population on effective technologies, currently on the	Kutaisi City hall USAID GIZ EU

		green development and how the population can support these processes) • Prepare information material for residents on energy efficiency measures conducted by signatory cities of the Covenant of Mayors, and relevant outcomes • Regular meetings with population; prepare PR workers within cooperatives • Involve the population in preparing and implementing pilot projects		market. • Several pilot projects (2 per year) with maximum involvement of local population are implemented	

3. Maximum information for the Kutaisi Municipality and City Council Members					
Local authorities are informed on the advantages and perspectives of sustainable energy consumption in the city, and on the social and economic benefits of this initiative.	• Kutaisi City Hall • Kutaisi City Council	• Information seminars for the representatives of Kutaisi City Hall and City Council on the advantages and perspectives of sustainable energy consumption in the city. • Support the participation of representatives of City Hall	• Kutaisi City Hall; • Kutaisi City Council; • Regional Energy Efficiency Center	• Illustration materials prepared for information-education meetings • Information meetings conducted (at least twice a year) • Experts from EU and other donor countries invited to conduct	• EC-LEDS • USAID • EU-COM • GIZ • Partnership for mitigation • Projects on greenhouse gas emissions

		and City Council in meetings and conferences connected to the Covenant of Mayor's process at local and international levels. • Involve mass media representatives in high level meetings to be held in frames of the Covenant of Mayors to achieve maximum positive publicity on the ongoing processes • Ensure the participation of interested parties in decision making within the framework of the COM		seminars on modern technologies and approaches • Decisions, potential projects and measures covered by mass media • Representatives from City Hall and City Council fully involved in the current processes at local and international levels • Regularly updated information on the City Hall web site on current processes and projects	reduction • Third national communication of Georgia on Climate Change

Long term strategy (2018-2020)	• Kutaisi City • Kutaisi City Council • Kutaisi • Private sector • Non-governmental sector	The main goal of long term strategy is to integrate the private sector into the processes of SEAP implementation and overcome the identified barriers; to carry out information campaigns aimed at the private sector and local population on worldwide standards, as well as the necessity and role of restrictions to ensure the sustainability of energy consumption.	• Kutaisi City Hall • Kutaisi City Council • Energy Efficiency Center • Private sector initiative group • CoM programs and projects	• Kutaisi authorities are ready to introduce new standards and enforce certain restrictive measures to support the COM and synchronize with EU directives • The population and private sector are aware of the necessity to carry out these measures

1. Involving the private sector in the implementation of SEAP goals					
• Enhancing the involvement of the private sector in SEAP by providing them with information on energy efficient and economically beneficial technologies, and offering programs on cooperation between public and private sectors	• Private sector • Private sector initiative group	• Establish annual exhibition/festival of innovations and technologies to help the private sector to enhance their knowledge of innovative technologies • Encourage the private sector to use innovative technologies (for instance, by reducing some local payments and taxes for those companies introducing energy efficient technologies) • Stimulate research work in educational institutions and the private sector • Establish a Consulting service for the private sector to increase success • Establish funds to facilitate the introduction of new technologies and reduce risks connected with adaptation • Support private sector initiative groups, to facilitate their maximum involvement in the COM	• Kutaisi City Hall • Energy Efficiency Center • Private sector • Non-governmental sector	• Events conducted every year • Incentive mechanisms to ensure involvement of private sector to use new technologies • Energy efficiency and Technologies Center established to provide consulting service on new technologies • Risk insurance fund(s) established for private sector to manage risks connected to technologies • Initiative groups established in different sectors which act as the main link between the government and the private sector • Representatives of the private sector are involved in international processes, associations and professional networks	• Kutaisi City Hall • Private sector • EU COM • GEF • UNFCCC • programs

2. **Intensifying consultations with interested parties while introducing restrictive measures and standards**					
Intensifying consultations with interested parties (city residents, private sector, non-governmental sector) on the restrictive measures and standards to be introduced by the Municipality in different sectors (construction, transport, waste management)	• Kutaisi City Hall • Kutaisi City • Kutaisi residents • Kutaisi private sector • Non-govern • mental sector	• Ensure maximum information on standards and restrictive measures elaborated for the sectors, considered in the city sustainable energy plan - to the city population, private sector and other target groups • Prepare information points and TV programs explaining social and environmental benefits brought by the mentioned measures • Prepare/train activists to conduct everyday work with target groups	• Kutaisi City Hall • Energy Efficiency and Innovative Technologies Regional Center • Private sector initiative groups • Non-governmental sector	• Specialists prepared to work regularly with target groups • Explanatory work and consultations on restrictive measures and necessary standards for implementation of SEAP are conducted for population and different target groups by non-governmental sector on a regular basis • Mass media is actively involved in information to the public on social and environmental benefits of the measures (clips, discussions, etc.)	• Kutaisi City Hall • Kutaisi City Council

3. **Identifying barriers through consultations with interested parties**					
Identifying barriers that can arise when restrictive measures and new standards are introduced, through consultations with the interested parties	• Kutaisi City Hall • Kutaisi City Council • Kutaisi residents • Kutaisi private sector • Non-governmental sector	• Identify barriers during the process of consultations with the local population on restrictive measures and standards, developed for the sectors in the SEAP • Develop measures to overcome the barriers identified, based on consultations with target groups	• Kutaisi City Hall • Kutaisi City Council	• Groups (private sector initiative groups, non-governmental sector, mass media) are prepared to conduct consultations • Barriers in each SEAP sector are identified • Measures to overcome the barriers are developed with the target groups	• Kutaisi City Hall

4. Raising Awareness of decision makers as well as the public and private sectors on the role of restrictive measures and standards in ensuring sustainable energy consumption					
Develop and implement awareness raising and incentive programs for target groups to ensure smooth introduction of the restrictive measures and standards (for instance, energy efficiency). This will be especially effective for decision makers and implementators to raise awareness and to prepare them for the necessary measures.	• Kutaisi City Hall • Kutaisi City Council • Kutaisi residents • Kutaisi active private sector	• Inform decision makers and persons responsible for implementation on successful and unsuccessful international practices • Decision makers and persons responsible for implementation participate in the processes related to the Covenant of Mayors and international low emissions development. • Special attention should be paid to the necessity of sustainable consumption of energy in Georgia to ensure the independence of energy supply, while preparing information on restrictive measures and new standards for decision makers and implementators • While highlighting the decisions made on restrictive measures and new standards for the population, mass media should pay special attention to social, environmental and tourism issues and long term economic effects	• Kutaisi City Hall • Programs and projects within the frames of Covenant of Mayors	• Decision makers and implementators are involved and well informed about current international processes, the obligations of Georgia related to climate change and energy efficiency • Information packets are prepared with clear analyses of compliance to the process of the Covenant of Mayors with EU Directives Good practices manuals are developed • Involvement of foreign consultants is necessary	• Government of Georgia • EC-LEDS • EU-CoM • GIZ • Clima East • And other proposed future programs

Implementation strategy

- The Kutaisi City Council will adopt the present strategy and monitor its implementation as an integral part of the City Development Action Plan.
- Kutaisi City Hall is responsible for updating and implementing the strategy.
- The Energy Efficiency and Innovative Technologies Regional Center is responsible for preparation of local specialists for the strategy implementation and monitoring. For this purpose, current international and local programs conducted within the frames of the Mayors Initiative shall be used.
- Awareness raising and information materials will be prepared using some external resources (non-governmental sector).
- Kutaisi City Hall will cooperate with external bodies to organize conferences , technology exhibitions, and/or trainings and seminars.

Monitoring, Verification and Reporting on the Execution of the Kutaisi Sustainable Energy Development Plan and Greenhouse Gas Emissions Reduction

For planning and implementing monitoring measures to carry out the Kutaisi SEAP and greenhouse gas emissions reduction plans, the way local self-government reforms are fulfilled is of significant importance. This is also true of the internal organizational structure of its executive body (compliance to legislative amendments). The Parliament approved a new self-government code on February 6, 2014 and its implementation is expected to begin after local self-government elections in 2014. According to this, eight out of twelve self-governing cities in Georgia are signatories to the Covenant of Mayors. The effectiveness of local financial and human resource development and growth are key to the progress of self-governing units. A lack of these resources and appropriate technical skills and knowledge is one of the biggest barriers for cities to prepare and carry out their Sustainable Energy Development Plans.

Therefore, in this transitional phase, a monitoring plan could offer several options. Nevertheless, a proper distribution of functions and the clear separation of rights and responsibilities between internal structural units of municipalities is primordial, along with access to external resources. Thus, the approach proposed implies the joint use of internal and external resources for monitoring.

The Action plan development process showed that one of the most important problems of Kutaisi, Batumi and other cities of Georgia is obtaining data from various sectors on energy consumption, which is necessary for the base year emissions inventory. In many cases, no data accounting system for assessment of emissions exists at all, as they were not used previously to evaluate economic parameters. Sometimes existing database information requires additional processing, which can only be made those who own the data source because there is always additional commercial information that may be confidential. Generally, collecting necessary data requires significant time and human resources, however municipalities (except for some larger ones) do not have well organized statistical/analytical tools or analytical departments. This hinders the process of developing an action plan or creating a monitoring process.

One of the main elements of the National Communications of Georgia on Climate Change is the greenhouse gas inventory. This document, covers emissions across the country from energy, transport, industry, agriculture, changes in land use and management of waste and waste wate. However, emissions from such sectors as buildings, tourism, etc. are not considered. Calculations for disaggregated emissions at the municipal level are also missing. Some steps were taken in this regard during the preparation of the Third National Communication (2012 - 2014), where an emissions baseline scenario was calculated for two municipalities (the cities of Batumi and Poti) for 2011. The main accent was placed on transport, building and waste sectors during the disaggregation process.

In order to reduce risks realted to data collection the "Monitoring" section of the action plan contains a monitoring performance methodology intended to avoiding as many existing barriers as possible. One such measure is to create a data registry necessary for baseline scenario monitoring. The registry will be regularly updated with information collected, summarized and systemized by the group[79] responsible for carrying out the monitoring of the Kutaisi Sustainable Energy Action Plan. Monitoring, verification and reporting will be carried out without any significant waste of time, based on regular updates of available data.

For internal monitoring and analysis a department within Kutaisi City Hall should be responsible for using software (easy to use even for users without deep knowledge of the field) to calculate baseline scenario emissions and quantities of reduced emissions and other measures, for combined data based on the BAU (traditional way of scenario development) approach. Local staff will require software training to ensure quality information.

The input of invited experts must be considered-- at least for the first mandatory report-- to prepare periodic reports on Action Plan Implementation monitoring which is based on the "Covenant of Mayors" initiative conditions.

Main activities included in the Monitoring and Reporting process of Kutaisi:

1. Regular update of the Baseline Scenario (BAU);
2. Assessment of emissions reduced after measures are taken and projects implemented;
3. Development of final report.

At the current stage, parties responsible for these processes under the current action plan are:

1. The Kutaisi Municipality, which is responsible for gathering statistical information (GDP, population, per capita income, share of economic activities/economic sectors in GDP, etc.) about main KPIs, describing city development processes. The baseline scenario could be done by external resources as well, if they are accredited by the municipality for conducting this work. The calculation of the Baseline scenario and its subsequent renewal methodology will be sent to the City Hall under the "Low Emission Development Strategy" by the Georgian Government, coordinated with the EU "Covenant of Mayors". Factors used for emissions have to be agreed with responsible authority of the UN Framework Convention on Climate Change in Georgia and low emission development process.
2. Implementing unit/project owners, who directly gather the necessary information to calculate reduced emissions after the implemented measures and projects are carried out. The Municipality should provide the implementers with appropriate data collection methodology and ensure periodic verification. The Municipality is responsible for calculating and verifying the final emissions, although this can also be done by external bodies accredited by the "Covenant of Mayors". The periodic verification of activity data provided by the project implementer is the Municipality's responsibility.

[79] Employees of relevant City Hall offices or Energy Manager specially appointed by the City Hall.

3. The City Hall, which is responsible for preparing the final report; its approval is City Council's prerogative after which it will be submitted to the EU.

This document describes the following: monitoring elements, general parameters that have to be monitored during SEAP implementation, quality control and quality assurance (QA/QC) procedures for different-type and emission factors. These will be the basis for a specific year baseline scenario to be updated, and by which reduced emissions are calculated.

Unit Responsible for Monitoring in the Kutaisi Municipality

The responsibility for preparing and implementing the Covenant of Mayors and Action Plan (SEAP), and updating them according to new circumstances and development plans, belongs to the Strategic Planning, Investment and Economic Development Department. This department is responsible for carrying out monitoring, analyzing results and integrating them into the action plan process then verifiying and monitoring data. Finally this Department will prepare and submit a final monitoring report to the City Council for approval before submitting it to the EU. This Department is also responsible for organizing data collection and improving data quality and updating the statistics systematically, as well as finding new sources of data. The Department can use other Municipal divisions and LLCs as well as certified external resources. The Municipality plans to rehabilitate a former administrative building located in the Botanical Garden and establish a training/demonstration center for energy-efficient and renewable technologies. If the project is implemented it will become an incubator for developing staff to support the Municipality to update and monitor the Sustainable Energy Development Plan, prepare project offers, mobilize investments and advertise new, efficient technologies.

There are five main sectors in the Sustainable Energy Action Plan of Kutaisi: energy consumption in buildings, energy consumption in the transport sector, street lighting energy consumption, methane emissions from the waste sector and increased emissions absorption through the development of green areas. Toevaluate each sector's baseline scenario, it is necessary to monitor each type of activity data. The baseline data is given below.

In addition to activity data, it will be necessary to monitor and measure each project implemented based on quantitative estimations of emissions reduction and comparing total emission savings against the baseline scenario. The final reduction amounts will be determined on the basis of results comparison analyses. Thus, at this stage, Kutaisi City Hall is considering two options of monitoring and collection of sector related data: collection of statistical data by the corresponding City Hall department or data archiving and primary processing at the energy-effective and renewable technologies training-demonstration center. The first option seems easily implementable at this stage, but there has not been clearly decided yet whether a common data archive of all sectors will be created, or whether the data will be archived in the departments that are responsible for managing the sector.

Fig. 25 shows City Hall offices and LCC-s, responsible for data collection.

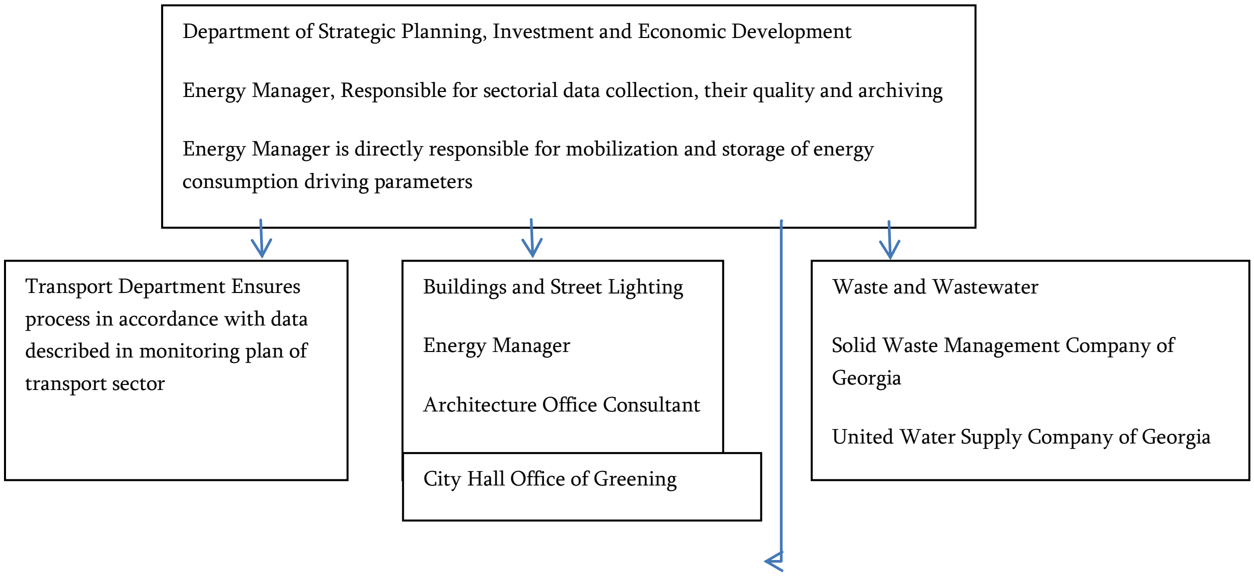

Fig. 25. Monitoring Process Management

Four types of data will be collected and evaluated to prepare a monitoring report for each sector:

- Annual emissions in CO_2 equivalent;
- Measures and project implementation statuses, and emission savings, for the monitoring stage;
- Driving parameters (KPIs) of the baseline scenario (for example: for the transport sector – population, GDP, or income growth and allocation of passenger-kilometers to transport types;
- Economic and social effects of the measures taken.

In addition to these types of data primary parameters in the monitoring process taken from different sources and secondary data, can be automatically calculated via muni_EIPMP software.

A certified monitoring group from the Kutaisi Municipality will be responsible for reporting. Every two years a report will be submitted to an independent third party for verification[80]. This party is likely to be provided by the EU Covenant of Mayors. Reporting structure of mentioned monitoring will be decided by the monitoring group and will not conflict with the common format developed and proposed by the Covenant of Mayors.

[80] Monitoring report frequency is determined by the "Covenant of Mayors" Office

General and Sector Related Driving Parameters

The purpose of this parameter schema is to update the baseline scenario taking current significant social and economic changes in Kutaisi into account.

Data/ Parameter # 2.1	**Population size throughout the monitoring year**
Dimension:	Quantity
Description:	Primary data; Annual Monitoring
Used Source:	Statistical annual (www.Geostat.ge) and local statistics
Value used in the SEAP:	**196,600 (2012)**
Rationale for using these data, or measure/assessment method:	If generated emissions can not be measured through the waste sector (measurements usually do not happen without project implementation) the annual methane emissions shall be recalculated in accordance with annually observed and measured parameters.
Additional comments:	Size of population throughout the monitoring year is used to re-verify certain values, for data control and to monitor the trend of per capita emissions.

Data/Parameter # 2.2	**Population Growth Rate (percentage)**
Dimension:	%
Description:	Calculated data; Annual monitoring. This parameter is mainly used for developing a Business as Usual (BAU) scenario, to assess emissions increase for electricity, fuel, waste, waste water, industry and other fields.
Used Source:	The source is a parameter evaluated at the national level by the Ministry of Energy of Georgia. National level data have been used in the MARKAL model reduced to the city scale, based on statistical data about past population growth.
Value used in the SEAP:	0.5
Rationale for using these data, or measure/assessment method:	Population is one of the leading parameters for emissions prediction under the IPCC social-economic development scenarios. In order to assess and forecast energy consumption along with amounts of waste and their emissions, demographic change forecasts are necessary.
Additional comments:	To prepare the SEAP forecast the same number (annual 0.5%) has been taken that is used by the Ministry of Energy to plan the energy sector based on the MARKAL model. This parameter will be defined during the low-emissions strategy development process. The Forecast is annual up to 2020, inclusive. The population size during the monitoring year is enough for monitoring. This parameter is necessary only for a BAU update.

Data/Parameter # 2.3	**Gross Domestic Product (GDP) in the monitoring year**
Dimension:	Million GEL
Description:	Calculated data; Annual monitoring
Used Source:	Statistical annual (www.Geostat.ge) and local statistics. This SEAP source was the Kutaisi Municipality.
Value used in the SEAP:	This value wasn't used in SEAP because it did not exist. In the future, however, monitoring should be evaluated.

Rationale for using these data, or measure/assessment method:	
Additional comments:	The National Statistics Office provides information about the region's annual GDP. In this case, Imereti region's GDP and total Imereti population make it possible to determine per capita GDP in the Imereti region and then--during the monitoring year--to estimate the GDP of Kutaisi by multiplying by the number of the city population. This is one the method of assessment. Another method can be used, which is more accurate: The size of the GDP in the monitoring year is used for additional testing for different values; to control data and monitor emission trends per GDP unit; and to estimate emissions intensity during economic development.

Data/Parameter # 2.4	**Gross Domestic Product (GDP) Growth Rate Forecast (%)**
Dimension:	%
Description:	Calculated data; This is calculated by the Ministry of Economy and Sustainable Development of Georgia, Analytical Department of the Ministry of Energy and other international monetary structures (World Bank, IMF, etc.)
Used Source:	The source is a parameter evaluated at the national level and made on behalf of the Ministry of Energy of Georgia. National level data used in the MARKAL model have been used, and corrected for the scale of the city.
Value used in the SEAP:	5% before 2018, 6 afterwards
The Rationale for using these data, or measure/assessment method:	These data are needed to estimate future emission trends and are used only if a BAU scenario update is necessary.
Additional comments:	

Emission Factors

Data/ Parameter # 2.4	**Grid emission factors CO2 t/MWh**
Dimension:	T **CO2**/MWh
Description:	Primary data. Calculated at the national level and provided to municipalities
Used Source:	Calculated especially for use for SEAP, there is also a value calculated for the Kyoto Protocol's Clean Development Mechanism projects (Ministry of Environment and Natural Resources Protection of Georgia)
Value used in the SEAP:	0.136
Rationale for using these data, or measure/assessment method:	The emission factor is calculated by dividing annual emissions from the power sector by the annual generation of electricity.
Additional comments:	This emission factor will be calculated centrally for controlling low emission development strategy monitoring. It will be delivered to municipalities to use it in their SEAPs. During SEAP preparation, the used grid emission factor is calculated according to averages since Kutaisi does not produce electricity independently, but receives it from the centralized energy system of Georgia.

Data/ Parameter # 2.5	Natural Gas (NG) emission factors
Dimension:	T/TJ, or Kg/TJ
Description:	Primary data
Used Source:	At this stage, the IPCC calculated typical value is being used (exploited for level 1 calculations)
Value used in the SEAP:	55.78 CO_2 T/TJ; 5 CH_4 Kg/TJ; 0.1 N_2O Kg/TJ.
Rationale for using these data, or measure/assessment method:	
Additional comments:	It is best to use the country's calculated value which depends on the natural gas calorific value (NCV). This value should be updated constantly during monitoring to ensure updated information on used gas caloricity.

Data/ Parameter # 2.6	Gasoline
Dimension:	T/TJ, Kg/TJ
Description:	Primary data
Used Source:	At this stage, the IPCC calculated typical value is being used (exploited for level 1 calculations)
Value used in the SEAP:	68.6 TCO_2/TJ; 20 kg CH_4/TJ; 0.6 kg N_2O /TJ.
Rationale for using these data, or measure/assessment method:	
Additional comments:	It is best to use the country's calculated value, depending on the carbon content of gasoline. This value should be updated regularly during monitoring to ensure updated information on imported gasoline caloricity.

Data/ Parameter # 2.7	Diesel
Dimension:	T/TJ, Kg/TJ
Description:	Primary data
Used Source:	At this stage, the IPCC calculated typical value is being used (exploited for level 1 calculations)
Value used in the SEAP:	73.3 T CO_2/TJ; 5 Kg CH_4/TJ; 0.6 Kg N_2O /TJ.
Rationale for using these data, or measure/assessment method:	
Additional comments:	It is best to use the country's calculated value, depending on the carbon content of diesel. This value should be updated constantly during monitoring to ensure updated information on imported diesel caloricity.

Data/ Parameter # 2.8	Net Calorific Value of Different Fuels (NCV for NG, Gasoline, Diesel)
Dimension:	
Description:	Primary data. These data shall be collected at the national level from fuel importers.
Used Source:	These data should be collected for each type of fuel used in the country. The information sources are mainly fuel importers and distributors.
Value used in the SEAP:	At this stage, typical values are used in the SEAP provided by the IPCC.
Rationale for using these data, or measure/assessment method:	
Additional comments:	Systematic updates are necessary that take into account fuel parameters. Ideally typical data should be taken from local data if available.

Activity Data Necessary for Kutaisi Transport Sector Monitoring

Data to be Collected for Municipal Buses

Data/ Parameter # 3.1.1	**Quantity of municipal buses**
Dimension:	Quantity of buses in the monitoring period (annual value)
Description:	Primary data
Used Source:	City bus service company, " Kutaisi Auto Transport" LTD. Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**194**(Diesel-194)
The Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.1.2	**Average distance travelled by one bus a year by fuel type (gasoline, diesel, gas)**
Dimension:	Km/y
Description:	Primary data
Used Source:	City bus serving 12 private shipping companies. Provided to the SEAP by Kutaisi Municipality Transport Service.
Value used in the SEAP:	**40,000** km/y
Rationale for using these data, or measure/assessment method:	
Additional comments::	This data should be taken by the monitoring group directly from private shipping companies, showing the daily kilometrage of buses on which annual data is then calculated. Data validation and verification is the responsibility of the Kutaisi Municipality Transport Service. The municipality should verify data against used fuel expenses.

Data/ Parameter # 3.1.3	**Total distance traveled by all buses annually (by fuel type)**
Dimension:	Trans.Km
Description:	Secondary data, calculated by the MUNI_EIPMP
Used Source:	Data # 3.1.1 and 3.1.2
Value used in the SEAP:	**7,760,000**
Rationale for using these data, or measure/assessment method:	
Additional comments::	This data will be verified by the amount of fuel used by buses annually.

Data/ Parameter # 3.1.4	**Average cost of 1 bus diesel per 100 km**
Dimension:	L/100 km
Description:	Primary data
Used Source:	Bus Service Company –"Kutaisi Auto Transport". Provided to the SEAP by Kutaisi Municipality as a possible alternative source.

Value used in the SEAP:	**38 L/100 km**
Rationale for using these data, or measure/assessment method:	
Additional comments::	This data should be checked with bus registration certificates and examined in case of significant differences.

Data/ Parameter # 3.1.5	**Annual consumption of fuel by all buses (by fuel type – gasoline, diesel)**
Dimension:	L/y
Description:	Secondary data calculated by the muni_EIPMP
Used Source:	Provided to the SEAP by the Batumi municipality
Value used in the SEAP:	**2,948,800 L (diesel)**
Rationale for using these data, or measure/assessment method:	
Additional comments::	Data is calculated by the monitoring group and checked against fuel amounts issued. In Kutaisi's case only diesel is used by buses.

Data/ Parameter # 3.1.6	**City bus load factor**[81]
Dimension:	Passenger km/trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.1.7. if it is assessed, or estimated through another method
Used Source:	For the SEAP it is calculated from Parameter 3.1.7 provided by the Kutaisi Municipality
Value used in the SEAP:	**15.05**
Rationale for using these data, or measure/assessment method:	This parameter is used only to assess greenhouse gas emissions reductions after measures taken in the sector. The GHG annual inventory from the transport sector is not dependant on it.
Additional comments::	These data can be assessed through surveys, bus tickets sold at public transport stops, etc. If Parameter 3.1.7 (mobility) is known, this parameter may be calculated as 3.1.7/3.1.1/3.1.2.

Data to be Collected for Municipal Minibuses

Data/ Parameter # 3.2.1	**Quantity of municipal minibuses**
Dimension:	Quanity of buses during the monitoring period (annual value)
Description:	Primary data
Used Source:	City Bus Service Company. Provided to the SEAP by Kutaisi Municipality

[81] Passenger load factor of transport measures the capacity of utilization of public transport services

Value used in the SEAP:	**587** (diesel)
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.2.2	**Average distance traveled by one minibus a year according to consumed fuel type (gasoline, diesel, gas, electricity)**
Dimension:	Km/y
Description:	Primary data.
Used Source:	Minibus companies Provided to the SEAP by Kutaisi Municipality Transport Service
Value used in the SEAP:	**60,000** Km/y
Rationale for using these data, or measure/assessment method:	This data should be taken directly by the monitoring group from minibus companies. It should also show the daily kilometrage of buses, for extrapolating annual data. Data validation and verification will be the responsibility of Kutaisi Municipality Transport Service. The municipality should verify data against used fuel expenses.
Additional comments::	

Data/ Parameter # 3.2.3	**Average distance travelled by all minibuses a year by consumed fuel type (gasoline, diesel, gas)**
Dimension:	km/y
Description:	Estimated data. Is calculated by the MUNI_EIPMP
Used Source:	Data #3.2.1. and 3.2.2.
Value used in the SEAP:	**35,220,000**
Rationale for using these data, or measure/assessment method:	
Additional comments::	The Municipality should verify the data from Finance Department relative to consumed fuel expenses.

Data/ Parameter # 3.2.4	**Average diesel expenses of one minibus per 100 km**
Dimension:	L/100 km
Description:	Primary data.
Used Source:	Provided to the SEAP by Batumi Municipality
Value used in the SEAP:	**15 l/100 km**
Rationale for using these data, or measure/assessment method:	
Additional comments::	These data should be checked with minibus registration certificates and interpreted in case of significant differences.

Data/ Parameter # 3.2.5	**Average fuel consumption by all minibuses according to fuel types (gasoline, diesel, gas)**
Dimension:	L/year
Description:	Secondary data. Shall be calculated by the monitoring group
Used Source:	Calculated by the muni-EIPMP Data #3.2.1. ; 3.2.2. and 3.2.4
Value used in the SEAP:	**5 283 000 L (diesel)**
Rationale for using these data, or measure/assessment method:	
Additional comments::	These data are calculated by the monitoring group and should be compared to amounts of fuel provided by the Transport Service in the Finance Department.

Data/ Parameter # 3. 2.6	**Transport's (minibus) Passenger Load Factor**
Dimension:	Passenger.km/Trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.2.7. if it is assessed or by another method
Used Source:	Calculated for the SEAP from # 3.2.7 provided by Kutaisi Municipality
Value used in the SEAP:	**8**
Rationale for using these data, or measure/assessment method:	This parameter is used only for assessing GHG emission reductions after measures are taken in the sector. The greenhouse gas annual inventory from the transport sector is not dependant on it.
Additional comments::	These data can be assessed through surveys, bus tickets sold at public transport stops, etc. If 3.2.7 parameter (mobility) is known, this parameter may be calculated #3.1.7/3.1.1/3.1.2#3.2.7/3.2.1/3.2.2

Private Cars (Motor Cars)

Data/ Parameter # 3.3.1	**Amount of private cars registered in Kutaisi (by fuel types)**
Dimension:	Quantity of transport
Description:	Primary data
Used Source:	Ministry of Internal Affairs – Patrol Police Department. Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**45,305 (Total)** **31,121 (gasoline) ; 7,836 (diesel); 6,348 (bottled gas).**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.3.2	Average annual distance travelled by one vehicle (by fuel type is desirable)
Dimension:	Km/year
Description:	Primary data.
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**9000 km/year**
Rationale for using these data, or measure/assessment method:	The National Statistics Office and interviews with drivers. Interviews shall identify average daily kilometrage to be extrapolated for annual calculations. Survey results should meet reliability criteria.
Additional comments::	Interviews and surveys to determine daily kilometrage and SEAP implementation will be conducted simultaneously.

Data/ Parameter # 3.3.3	Average distance travelled by all motor cars a year (by fuel types)
Dimension:	Trans.km/year
Description:	Calculated data
Used Source:	Calculated by the MUNI_EIPMP Data # 3.3.1 and 3.3.2
Value used in the SEAP:	**407,745,000**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.3.4	Fuel consumption per 100 km (by fuel types)
Dimension:	L/100 km m^3/100 km kW.h/100 km
Description:	Primary data
Used Source:	Taken from the registration certificate of a motor vehicle
Value used in the SEAP:	**Gasoline -10 l/100 km** **Diesel -8 l/100 km** **Natural Gas-10 m^3/100 km**
Rationale for using these data, or measure/assessment method:	Provided by the Kutaisi Municipality to prepare this SEAP
Additional comments::	These data are rechecked via registration certificate and surveys.

Data/ Parameter # 3.3.5	Fuel consumption of all motor cars by fuel types (gasoline, diesel, gas)
Dimension:	L/year
Description:	Secondary data. Shall be calculated by the monitoring group.
Used Source:	Calculated by the muni_EIPMP Data #3.3.1. ; 3.3.2. and 3.3.4
Value used in the SEAP:	**28,008,900 lit. (gasoline)** **5,641,920 lit. (diesel)**

	57,132,000 m³ (natural gas)
Rationale for using these data, or measure/assessment method:	
Additional comments::	These data are calculated by the monitoring group and compared to the fuel consumed in the city. Significant error is expected, however.

Data/ Parameter # 3.3.6	**Transport Load Factor**
Dimension:	Passenger km/ trans.km
Description:	This parameter should be evaluated by statistical methods and surveys and could be calculated from Parameter 3.3.7. if it is assessed, or estimated through another method.
Used Source:	Calculated for the SEAP from Parameter 3.3.7 provided by the Kutaisi Municipality
Value used in the SEAP:	**1.64**
Rationale for using these data, or measure/assessment method:	This parameter is used only to assess greenhouse gas emission reductions after measures are taken in the sector. The GHG annual inventory from transport sector is not dependant on it.
Additional comments::	This data can be assessed as a result of a survey if Parameter 3.3.7 is known (mobility of private motor cars). This parameter can be calculated #3.3.7/3.3.1/3.3.2

Municipality Service Fleet

Data/ Parameter # 3.4.1	**Kutaisi municipality service vehicles (by fuel type)**
Dimension:	Amount of transport
Description:	Primary data
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**total 53** **gasoline: 45; diesel: 8**
Rationale for using these data, or measure/assessment method:	The Kutaisi Municipality transport service is responsible for this data.
Additional comments::	Agricultural Activity Department of the Municipality

Data/ Parameter # 3. 4.2	**Average distance travelled per vehicle each year (by fuel and transport types)**
Dimension:	km/ year
Description:	Primary data
Used Source:	Provided to the SEAP by Kutaisi Municipality Transport Service
Value used in the SEAP:	**8000 km/year**
Rationale for using these data, or measure/assessment method:	Kutaisi Municipality Transport Service is responsible for these data
Additional comments::	

Data/ Parameter # 3.4.3	Average distance travelled by municipality service vehicles annually
Dimension:	Trans.km/year
Description:	Calculated data.
Used Source:	Calculated by the muni_EIPMP Data # 3.4.1 and 3.4.2
Value used in the SEAP:	**424,000**
Rationale for using these data, or measure/assessment method:	
Additional comments::	Verification to be carried out accordance with fuel consumed.

Data/ Parameter # 3. 4.4	Fuel consumption per 100 km (by fuel and transport types)
Dimension:	L/100 km
Description:	Primary data.
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**Gasoline: 8** **Diesel: 35**
Rationale for using these data, or measure/assessment method:	The Kutaisi Municipality Transport Service is responsible for these data
Additional comments::	

Data/ Parameter # 3.4.5	Annual fuel consumption of the entire municipal fleet (by fuel type)
Dimension:	Litre
Description:	Secondary data. Calculated by the monnitoring group
Used Source:	Calculated by the muni_EIPMP Data #3.4.1. ; 3.4.2. and 3.4.4
Value used in the SEAP:	**28,800 (gasoline)** **22,400 (diesel)**
Rationale for using these data, or measure/assessment method:	
Additional comments::	Verification shall be carried out in accordance with consumed fuel.

Commercial Transport (Taxi)

Data/ Parameter # 3. 5.1	Taxi cabs of Kutaisi by fuel type
Dimension:	Number of taxis by fuel type
Description:	Primary data.
Used Source:	Provided to the SEAP by Kutaisi Municipality Transport Service

Value used in the SEAP:	**693 (Total)** **93 (on gasoline); 121 (on diesel); 479 (on bottled gas)**
Rationale for using these data, or measure/assessment method:	Kutaisi Municipality Transport Service is responsible for the data
Additional comments::	The primary verification of these data is the responsibility of the Kutaisi City Hall Transport Service but they can only control officially registered taxis. The reliability of the data is very low and likely to be reflected in total amount of fuel sold.

Data/ Parameter # 3. 5.2	**Average distance travelled by one taxi annually (by fuel types)**
Dimension:	km/year
Description:	Primary data.
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**50,000**
Rationale for using these data, or measure/assessment method:	The Kutaisi Municipality Transport Service is responsible for the data. These data for officially registered taxis can be obtained via the Revenue Service or taxi union. Estimations should be done through driver interviews.
Additional comments::	Primary verification of the data with different sources (tax) is a responsibility of the City Hall Transportation Service

Data/ Parameter # 3.5.3	**Average distance covered by all taxis annually (by fuel type is desirable)**
Dimension:	Trans.km/year
Description:	Calculated data.
Used Source:	Calculated by the muni_EIPMP Data # 3.5.1 and 3.5.2
Value used in the SEAP:	**4,650,000 (on gasoline);** **6,050,000 (on diesel);** **23,950,000 (m3 gas).**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3. 5.4	**Fuel consumption by transport type**
Dimension:	Lit./100 km m3/100 km
Description:	Primary data
Used Source:	Registration certificate of vehicle. Provided to the SEAP by Batumi Municipality
Value used in the	**Gasoline 10 L**

SEAP:	**Diesel 9 L** **Gas 11 m3**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter 3. 5.5	**Annual fuel consumption by taxis (by fuel types)**
Dimension:	L/year
Description:	Secondary data
Used Source:	Calculated by the muni-EIPMP Data #3.5.1. ; 3.5.2. and 3.5.4
Value used in the SEAP:	**465,000 (gasoline)** **544,500 (diesel)** **2,634,500 (natural gas)**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.5.6	**Passenger load factor of taxi cabs (load factor)**
Dimension:	Passenger km/ trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.5.7. if it is assessed, or if not, through another method.
Used Source:	Calculated for the SEAP based on Parameter 3.5.7 provided by the Kutaisi Municipality
Value used in the SEAP:	**1.64 correction is needed**
Rationale for using these data, or measure/assessment method:	The value is calculated within the framework of the SEAP. Mobility of taxi cabs is provided by the Municipality (Parameter 3.5.7)
Additional comments::	

Commercial Transport Small Trucks (up to 2 tons)

Data/ Parameter # 3. 6.1	**Small trucks used in Kutaisi**
Dimension:	Small trucks by fuel type

Description:	Primary data
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**Small Trucks [82] - 1425** **217- on gasoline; 1208- on diesel .**
Rationale for using these data, or measure/assessment method:	These data are the responsibility of the Kutaisi Municipality Transport Service.
Additional comments::	Primary verification of these data is a responsibility of Kutaisi City Hall Transport Service

Data/ Parameter # 3. 6.2	**Average distance travelled by one small truck a year (by fuel type is desirable)**
Dimension:	km/year
Description:	Primary data
Used Source:	Provided to the SEAP by Kutaisi Municipality Transport Service
Value used in the SEAP:	**30,000**
Rationale for using these data, or measure/assessment method:	The Kutaisi Municipality Transport Service is responsible for the data.
Additional comments::	Primary verification of these data is the responsibility of the City Hall Transport Service.

Data/ Parameter # 3.6.3	**Average distance travelled by small trucks a year (by fuel type is desirable)**
Dimension:	Trans.km/year
Description:	Calculated data
Used Source:	Calculated by the MUNI_EIPMP Data # 3.6.1 and 3.6.2
Value used in the SEAP:	**6,510,000 (on gasoline)** **36,240,000 (on diesel)**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

[82] Up to 2 tons load-carrying capacity

Data/ Parameter 3. 6.4	**Fuel consumption by transport types**
Dimension:	L/100 km
Description:	Primary data
Used Source:	Provided to the SEAP by the Kutaisi Municipality
Value used in the SEAP:	**Gasoline 16 l** **Diesel 14 l**
Rationale for using these data, or measure/assessment method:	
Additional comments::	These data should be checked with registration certificates of each motor vehicle and interpreted in case of significant difference.

Data/ Parameter # 3. 6.5	**Annual fuel consumption vehicle and fuel types**
Dimension:	L/year
Description:	Secondary data
Used Source:	Calculated by the MUNI_EIPMP
Value used in the SEAP:	**Gasoline 1,041,600 lit.** **Diesel 5,073,600 lit.**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.6.6	**Small trucks load factor (load factor)**
Dimension:	Ton km/ Trans.km
Description:	This parameter should be evaluated by statistical methods and surveys. It could be calculated from Parameter 3.6.7. if it is assessed, or estimated by another method if not.
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**1**
Rationale for using these data, or measure/assessment method:	Required to assess emission savings from implemented measures during the monitoring period Evaluation method required here.

Additional comments::	

Data/ Parameter # 3. 6.7	**Transported freight by all small trucks in a year (annual freight turnover)**
Dimension:	Ton km/year
Description:	Secondary data
Used Source:	Data #3.6.1*3.6.2*3.6.6.
Value used in the SEAP:	**43,186,770**
Rationale for using these data, or measure/assessment method:	
Additional comments::	These data can be verified through actually transported freight and kilometrage.

Commercial Transport (Heavy Trucks)

Data/ Parameter # 3. 7.1	**Number of heavy trucks in Kutaisi (diesel)**
Dimension:	Number of heavy trucks by fuel type
Description:	Primary data
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**853 (Total diesel)**
Rationale for using these data, or measure/assessment method:	Kutaisi Municipality Transport Service is responsible for this data
Additional comments::	Primary verification of these data is under the responsibility of the City Hall Transport Service.

Data/ Parameter # 3. 7.2	**Average distance covered annually by one heavy truck (by duel type is desirable)**
Dimension:	Km/year
Description:	Primary data
Used Source:	Provided to the SEAP by Kutaisi Municipality
Value used in the SEAP:	**15,000**
Rationale for using these data, or measure/assessment method:	Kutaisi Municipality Transport Service office is responsible for the data.
Additional comments::	The primary verification of these data is under responsibility of the City Hall Transport Service.

Data/ Parameter # 3.7.3	**Average distance covered annually by all heavy trucks (by duel type is desirable)**
Dimension:	Trans.km/year
Description:	Calculated data
Used Source:	Calculated by the muni-EIPMP Data # 3.7.1 and 3.7.2
Value used in the SEAP:	**12,795,000 (diesel)**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3. 7.4	**Fuel consumption by vehicle type**
Dimension:	L/100 km.
Description:	Primary data
Used Source:	Registration Certificate of a motor car. Provided to the SEAP by Kutaisi Municipality.
Value used in the SEAP:	**Diesel 30 lit.**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3. 7.5	**Annual fuel consumption by vehicle and fuel types**
Dimension:	L/year
Description:	Secondary data
Used Source:	Calculated by the muni_EIPMP
Value used in the SEAP:	**3,838,500 l diesel**
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 3.7.6	**Heavy truck load factor (load factor)**
Dimension:	ton-km/ car-km
Description:	Primary data
Used Source:	Provided by the Transport Service of the Municipality at present
Value used in the SEAP:	**18**
Rationale for using these data, or measure/assessment method:	Required to assess emission savings from implemented measures during the monitoring period. Evaluation method required here.
Additional comments::	

Data/ Parameter # 3. 7.7	**Transported freight by all heavy trucks in a year (annual freight turnover)**
Dimension:	Ton.km/year
Description:	Secondary data
Used Source:	Calculated by the MUNI_EIPMP Data #3.7.1*3.7.2*3.7.6.
Value used in the SEAP:	**230 310 000**
Rationale for using these data, or measure/assessment method:	
Additional comments::	These parameters can be verified through actual transported freight and kilometrage.

Data/ Parameter # 3. 7.8	**Fuel consumed by Kutaisi transport sector by fuel type**
Dimension:	L/year M^3/year
Description:	Primary data
Used Source:	The National Statistics Office and Kutaisi Municipality Transport Service are responsible for the data.
Value used in the SEAP:	This data has not been used for the SEAP.
Rationale for using these data, or measure/assessment method:	
Additional comments::	These data are very important for balance verification

Waste Management

Data/ Parameter # 4.1	**Amounts of waste (collected and deposited in a landfill daily) Current landfill in Kutaisi (Nikea)**
Dimension:	m^3 or ton
Description:	Primary data
Used Source:	The data has been provided by Kutaisi Municipality in the SEAP preparation process
Value used in the SEAP:	The landfill has been operating since 1956. 630m^3 of waste was deposited daily in 2012. Accumulated waste was approximated at 6.5 million m^3 (1.3 million t) by 2012.
Rationale for using these data, or measure/assessment method:	
Additional comments::	The landfill is currently active and expected to close in 2016 after opening a new area in Terjola. Methane will continue to be emitted for 30 more years unless collected and burnt.

Data/ Parameter # 4.2	**Nikea landfill parameters (area, depth, waste composition)**
Dimension:	Area -ha Depth -m Waste composition-%
Description:	Primary data. Used for methane quantitative assessment and monitoring will not be necessary in future/
Used Source:	The data have been provided by Kutaisi Municipality for the SEAP preparation process.
Value used in the SEAP:	Area -15 ha Depth - 12-157 m Waste composition : Organic waster 71%, Paper 6%, Textiles 3%, Polyethylene 6%, inert material 6%, metal 3% etc. 5%
Rationale for using these data, or measure/assessment method:	These data are used to estimate annual methane emissions in advance
Additional comments::	The landfill is currently active and expected to close in 2016. It will not be necessary to monitor these parameters after closing. If the project is implemented, methane measurements will be enough, or only theoretical calculations will be considered.

Data/ Parameter # 4.3	**Amount of collected and burnt methane locally**
Dimension:	m^3
Description:	Primary data. Being obtained through measurements
Used Source:	This data/quantity has been estimated by FOD model of the IPCC during the SEAP preparation process.
Value used in the SEAP:	Assuming that the landfill closes in 2016 and methane combustion is planned from 2017, an average 30 g CO_2 equivalent will be saved from emissions annually, equal to 128 g CO_2 equivalent in 4 years (2016 – 2020), or 89.5% of the generated amount.

Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 4.4	**Generated methane calculation (If waste area closes and project not performed)**
Dimension:	m^3 or ton
Description:	Secondary data. Generated methane amount shall be calculated through the first-line rotting model. The Monitoring Group is responsible for Calculations.
Used Source:	2006 IPCC Guidelines for National Greenhouse Gas Inventories, http://www.ipcc-nggip.iges.or.jp/public/2006gl (p. 3.36) This is ready-made software to input parameters.
Value used in the SEAP:	Parameters necessary for calculations: Population size Per capita waste (daily or annually) Waste composition (from new evaluations) Methane Emission Correcton Factor (MCF) -1 Rotting-capable organic carbon Waste composition DOC Food waste 0.15 Garden 0.20 Paper 0.40 Wood and straw 0.43 Textile 0.24 Diapers 0.24 Share of Rotting-capable practically rotten organic carbon (DOCF)-0.5-0.6 Share of methane in landfill gas (F)-50% Oxidation factor (OX)-0.1 (on controlled landfill)
Rationale for using these data, or measure/assessment method:	
Additional comments::	In case the landfill is not closed and the project to burn methane fails, methane measurement is likely to fail too, and these parameters will be observed through monitoring and generated methane assessment.

Outdoor Lighting Sector

Data/ Parameter # 5.1	**Total annual amount of electricity consumed for outdoor lighting**
Dimension:	kW.h/year
Description:	Primary data
Used Source:	Kutaisi City Hall Infrastructure Service office. This office is responsible for reporting on the amount of electricity annually consumed for outdoor lighting.
Value used in the SEAP:	**9,412,671 kW.h (2012)** **11,800,000 kW.h (2020 year forecast)**
Rationale for using these data, or	

measure/assessment method:	
Additional comments::	The data shall be verified by paid amounts.

Data/ Parameter # 5.2	**Quantity of energy-efficient (ECO-LAMPS) bulbs, which will be partially replaced by inefficient/old lamps and will be used in new installations**
Dimension:	Quantity of ECO-LAMPSlamps
Description:	Primary data
Used Source:	Project/measure implementating unit
Value used in the SEAP:	According to the measure, there will 85% new, ECO-Lamps in outdoor lighting by 2020. **14,700 pieces**
Rationale for using these data, or measure/assessment method:	
Additional comments::	If this measure is taken the issued to be clarified is what will happen to the old bulbs—will they be destroyed or given away, and if so—to whom?

Data/ Parameter # 5.3	**Energy saved by one ECO-LAMP bulb per hour**
Dimension:	kW.h
Description:	Primary data
Used Source:	Technical passport of the bulb
Value used in the SEAP:	**0.236** kW.h
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 5.4	**Emission savings through implemented measures (ECO-LAMPS)**
Dimension:	T CO2 equivalent
Description:	Secondary data calculated by the monitoring group annually
Used Source:	SEAP developing group
Value used in the SEAP:	Savings of a 911 t CO2 equivalent have been estimated by 2020
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Greening of Kutaisi

Data/ Parameter # 6.1	**Annual planting and growing seedlings (by species)**
Dimension:	Ha Number of plantings by species
Description:	Primary data
Used Source:	City greening service, botanical garden management
Value used in the SEAP:	Due to lack of a specific greening plan cultivation of 1 Ha area annually from 2014 has been allowed (100% growing seedlings) within the SEAP
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 6.2	**Annual tree cutting (by species)**
Dimension:	m^3
Description:	Primary parameter
Used Source:	City greening service, botanical garden management
Value used in the SEAP:	The SEAP assesses only the current accumulation of carbon in Kutaisi and annual accumulation before 2020. Tree cutting shall be considered during the monitoring process.
Rationale for using these data, or measure/assessment method:	
Additional comments::	

Data/ Parameter # 6.3	**Fires or other causes of damage to trees**
Dimension:	m^3
Description:	Primary parameter
Used Source:	City greening service, botanical garden management
Value used in the SEAP:	The SEAP assesses only the current accumulation of carbon in Kutaisi and the annual accumulation until 2020. Fires, tree and plant diseases and other causes of destruction of trees shall be considered in the monitoring process.
Rationale for using these data, or measure/assessment method:	
Additional comments:	

Data/ Parameter # 6.4	**Botanical garden area monitoring**
Dimension:	Ha
Description:	Primary parameter. Annual monitoring of area changes

Used Source:	Botanical garden
Value used in the SEAP:	The SEAP assesses the existing condition of the Botanical Garden. Only the current accumulation of carbon in Kutaisi and annual accumulation up to 2020 are assessed. Cuttings shall be considered in the monitoring process.
Rationale for using these data, or measure/assessment method:	
Additional comments:	

Data/ Parameter # 6.5	**Garden area changes (fire, diseases and reducing the number of trees)**
Dimension:	m^3
Description:	Primary parameter
Used Source:	Botanical garden
Value used in the SEAP:	The Botanical Garden's current condition and absorption up to 2020 have been assessed within the SEAP. Monitoring biomass changes will be annual.
Rationale for using these data, or measure/assessment method:	
Additional comments:	Typical indicators for the greening sector and characterizing indicators of regional forests for the Botanical Garden have been established at this stage (biomass increment, dry biomass quantity). Continuous monitoring will be made for all parameters used, and for relevant changes in calculations required when parameters are updated.

Data/ Parameter # 6.6	**Annual monitoring on CO_2 absorption changes**
Dimension:	T CO_2 a year
Description:	Secondary parameter. Calculated by the monitoring group
Used Source:	Calculated by the SEAP developing group
Value used in the SEAP:	The greening of Kutaisi covers 211.6 Ha (fragmentary covered plantation areas and Botanical Garden). On this territory now 13,635 t. of carbon are reserved with an annual absorption of 460.2 t CO_2. On 5 Ha of the Botanical Garden 615 t of carbon was deposited and annual absorption amounts to 17 t of CO_2.
Rationale for using these data, or measure/assessment method:	
Additional comments:	

Buildings Sector

Data/ Parameter # 7.1	**Annual energy consumption of municipal buildings**
Dimension:	MW.h/Year
Description:	Primary parameter
Used Source:	Kutaisi City Hall Financial Service. Final quality of data is under responsibility of Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	**13,203. 35**
Rationale for using these data, or measure/assessment method:	
Additional comments:	This data will be checked at Energo-pro Georgia and by energy audit estimations.

Data/ Parameter # 7.2	**Annual energy consumption of residential buildings**
Dimension:	MW.h/year
Description:	Primary parameter
Used Source:	Energo-pro Georgia. Final quality of data is under the responsibility of Energy Manager assigned by Kutaisi City Hall (or by the monitoring group)
Value used in the SEAP:	**99,477.54**
Rationale for using these data, or measure/assessment method:	
Additional comments:	These data may be checked by a survey of typical buildings or energy audit estimations.

Data/ Parameter # 7.3	**Annual energy consumption of commercial buildings**
Dimension:	MW.h/year
Description:	Primary parameter
Used Source:	Energo-pro Georgia. The final quality of data is under the responsibility of the Energy Manager assigned by Kutaisi City Hall (or monitoring group)
Value used in the SEAP:	**6370.51**
Rationale for using these data, or measure/assessment method:	
Additional comments:	These data may be checked by a survey of typical buildings or energy audit estimations.

Data/ Parameter # 7.4	Annual consumption of natural and liquid gas by municipal buildings
Dimension:	m^3/year; kg/year
Description:	Primary parameter
Used Source:	Kutaisi City Hall Financial Service. Final quality of data is under responsibility of Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	**Natural gas- 561,137 (m^3/year)** **Liquid gas - 460 (kg/year)**
Rationale for using these data, or measure/assessment method:	
Additional comments:	May be checked at gas supply company

Data/ Parameter # 7.5	Annual consumption of natural and liquid gas by residential buildings
Dimension:	m^3/year; kg/year
Description:	Primary parameter
Used Source:	Gas distribution company, serving Kutaisi. Final quality of data is under responsibility of Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	**Natural gas – 253,386.78** m^3
Rationale for using these data, or measure/assessment method:	
Additional comments:	

Data/ Parameter # 7.6	Annual consumption of natural gas by commercial buildings
Dimension:	m^3/year; kg/year
Description:	Primary parameter. Annual
Used Source:	Gas distribution company serving Kutaisi. Final quality of data is under responsibility of Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	**Natural gas-202.41 m^3**
Rationale for using these data, or measure/assessment method:	
Additional comments:	This data may be checked by a survey of commercial buildings or energy audit estimations.

Data/ Parameter # 7.7	**Annual consumption of firewood and diesel by municipal buildings**
Dimension:	m^3; l
Description:	Primary data
Used Source:	Kutaisi City Hall Financial Service. Final quality of data is under the responsibility of Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	**Firewood - 385.5 m3**
Rationale for using these data, or measure/assessment method:	
Additional comments:	

Data/ Parameter # 7.8	**Annual firewood consumption by residential buildings**
Dimension:	m^3
Description:	Primary parameter
Used Source:	Vouchers issued for residents. Final quality of data is under responsibility of Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	**Firewood – 83,340 m^3**
Rationale for using these data, or measure/assessment method:	According to experts' estimations, the annual consumption of firewood in Kutaisi is about 3000-4 000 m^3.
Additional comments:	Have to be checked with periodic surveys. Especially the fact that firewood consumption rates are much higher than vouchers issued.

Data/ Parameter # 7.9	**Annual consumption of firewood and diesel by commercial buildings**
Dimension:	MW.h/year
Description:	Primary parameter. Annual
Used Source:	Commercial buildings survey. Final quality of data is under responsibility of the Energy Manager assigned by Kutaisi City Hall.
Value used in the SEAP:	Nothing is being consumed now, but monitoring is necessary.
Rationale for using these data, or measure/assessment method:	
Additional comments:	This data may be checked by a survey of commercial buildings

Data/ Parameter # 7.10	**Annual CO_2 monitoring from all three sectors**
Dimension:	T/year
Description:	Secondary parameter. Annual

Used Source:	Calculated by the monitoring group
Value used in the SEAP:	**2012- 70,605.64** **2020- 145,692.93**
Rationale for using these data, or measure/assessment method:	
Additional comments:	

Data/ Parameter # 7.11	**Savings through measures carried out in buildings sector**
Dimension:	MW.h/per measure
Description:	Secondary parameter. Annually calculated for each measure.
Used Source:	Project executor (population, municipality, head of commercial building)
Value used in the SEAP:	This parameter is calculated in case each specific measure is carried out in accordance with the monitoring plan for each measure.
Rationale for using these data, or measure/assessment method:	Assessment/measurement of energy consumption with corresponding CO2 baseline scenario and actual measurements is required for all buildings and fuel types under the measures.
Additional comments:	Energy consumption can be reduced by various means (technical disconnections, disconnections because of unpaid bills, etc.). Therefore, it is necessary to prove that reductions have actually resulted from fulfilled measures without the intervention of other factors. Emissions savings estimation methods within the framework of the abovementioned measures will be described separately for each measure.

Sustainable Development Criteria: The monitoring report should also include the results of observations on sustainable development criteria/indicators:

- Increase the population's comfort and energy expenditure savings (per capita hot water consumption, expansion of heated area, approximation of per area energy consumption to European standards etc.);
- Promote residential condominiums;
- Improve comfort or or energy expense savings in municipal/commercial buildings (heat, electricity, hot water consumption per area unit);
- Implement waste recycling technologies;
- Expand per capita green areas;
- Reducte local pollutants (mainly in the transport sector);
- Increase the number of jobs;
- Contribute to gender equality;
- Demonstrate and pilot new technology;
- Promote private sector development;
- Municipalities can report on additional criteria, similar to measures carried out within the framework of the Sustainable Energy Action Plan;
- Main obstacles to the plan, ways to avoid and overcome barriers identified and steps towards achieving success.